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Pesticides of Concern in the Puget Sound Basin
A Review of Contemporary Pesticide Usage

Tetra Tech, Inc., Bellevue, WA

Prepared for

Environmental Protection Agency, Seattle, WA

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PESTICIDES OF CONCERN IN THE PUGET SOUND BASIN:

A Review of Contemporary Pesticide Usage

FINAL REPORT
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Prepared for
U.S. Environmental Protection Agency
Region X - Office of Puget Sound
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The Puget Sound basin is a demographically complex region that supports a diversity of economic activities, ranging from agriculture and forestry in largely rural areas to heavy industry and shipping in largely populated areas. A diverse group of opportunistic organisms that interferes with human activities is also associated with the development of the basin. These so called pest organisms are often controlled or eradicated with chemical substances that are commonly called pesticides. These diverse chemicals exhibit a wide range of effects on the environment and many are toxic to organisms other than the intended targets. Pesticides that have the potential to migrate to the waters of Puget Sound or rivers within the basin are of major concern, for their potential to cause to aquatic organisms.

This report addresses the amount and distribution of contemporary pesticides used in the basin and then assesses the potential for these pesticides to migrate to the aquatic environment and induce toxic effects on aquatic organisms. This task is accomplished by defining pesticide uses, locating sources of available information, and surveying these sources to determine quantities used on a country-wide basis. Collated information is used to characterize the environmental fate and toxicity of pesticides. A tiered scoring method is used to rank pesticides and to determine the level of concern for individual pesticides.

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by

Tetra Tech, Inc.

for

U.S. Environmental Protection Agency
Region X - Office of Puget Sound
Seattle, Washington

September 1988

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PREFACE

The Puget Sound Estuary Program, under the auspices of the U.S. Environmental Protection Agency (EPA) Office of Marine and Estuarine Protection, was initiated in 1985 to monitor and assess environmental damage to Puget Sound. It is co-managed by U.S. EPA Region X, the Puget Sound Water Quality Authority (PSWQA) and Washington Department of Ecology (Ecology). This report was prepared as part of that program to synthesize information on the usage of pesticides and their potential environmental effects in the Puget Sound basin, with a focus on identifying potential problem pesticides that may contaminate Puget Sound. This information is intended to provide a basis for future pesticide sampling and monitoring programs by federal and state agencies.

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The work assignment manager and author of this report was Dr. Gary A. Pascoe. Drs. James Erckmann, Jean Jacoby, and Les Williams, and Ms. Stacey Vineberg of Tetra Tech initiated the research phase of this project, and Dr. Williams served as technical reviewer of the draft report. Dr. Dave Eaton, University of Washington, provided expert advice during the initial stage of research. Ms. Marcy Brooks-McAuliffe and Ms. Sue Trevathan coordinated technical editing and publication.

EXECUTIVE SUMMARY

INTRODUCTION

The Puget Sound basin is delineated by the 12 counties that border the sound, the Strait of Juan de Fuca to the Elwha River, and the Strait of Georgia to the international border, and the consolidated watersheds that drain that area. The Puget Sound basin is a demographically complex region that supports a diversity of economic activities, ranging from agriculture and forestry in largely rural areas to heavy industry and shipping in largely populated urban areas. A diverse group of opportunistic organisms that interferes with human activities is also associated with the economic development of the basin. These so-called economic pests are often controlled or eradicated with chemical substances that are commonly known as pesticides.

As a chemical group, pesticides include a wide range of substances that vary in their specificity and may be generally toxic to many kinds of organisms (biocides), or may be targeted for control of specific categories of pests such as algae (algicides), weeds (herbicides), insects (insecticides), rodents (rodenticides), and snails and slugs (molluscicides). The numerous and varied types of pests for which control has been sought brought about the development of similarly numerous chemical substances. These chemicals exhibit an equally diverse range of effects to the environment and many are toxic to organisms other than the intended targets. Of these pesticides, the ones that have the potential to migrate from the site of application to the waters of Puget Sound or rivers within the watershed basin are of major concern for their potential to cause harm to aquatic organisms.

This report addresses these concerns over pesticides presently used in the basin by first determining the amount and distribution of contemporary pesticides used in the basin and then assessing the potential for these pesticides to migrate to the aquatic environment and induce toxic effects on aquatic organisms. This task is accomplished by defining categories of pesticide uses, locating sources of available information, and surveying these sources to determine quantities of pesticides used on a county-wide basis. Information collated from a variety of sources is used to characterize the environmental fate and toxicity of pesticides. Finally, a tiered scoring method, based on annual usage rates, and potential fate and toxicity in the aquatic environment, is used to rank pesticides and to determine the level of concern for individual pesticides in the Puget Sound basin.

Throughout the report pesticide "usage" indicates pounds of active ingredients applied over one year. "Active ingredients" are those chemicals with biocidal activity against intended target organisms. Inert ingredients in pesticide formulations are not addressed in this report because of the lack of information on their usage in the Puget Sound basin.

ASSESSMENT OF PESTICIDE USAGE

A comprehensive assessment of pesticide use in the Puget Sound basin has not been conducted previously. Only a few surveys have been performed, each one focusing on a specific group of pesticide users, such as the agricultural sector. In this report, usage of contemporary pesticides by all major groups of users is estimated for 20 different user categories in each of the 12 counties of the basin. These categories comprise major pesticide users in the basin and biocides of particular interest to Puget Sound. These categories were selected based on availability of pesticide usage information and suggestions from pesticide suppliers and representatives of state government agencies. The categories are identified as:

- Agriculture
- Federal agencies:
    - Department of the Army (Army)
    - Department of the Air Force (Air Force)

    - Department of the Navy (Navy)
    - Department of Agriculture (USDA)
    - Department of Interior (USDI)
    - Department of Transportation (USDOT)
    - Department of Energy (DOE)
    - Army Corps of Engineers
- State agencies:
    - Department of Natural Resources (WDNR)
    - Department of Transportation (WDOT)
    - Department of Wildlife (WDOW)
- County road departments
- Urban:
    - Cities/school districts
    - Commercial applicators
    - Private households
- Private timber companies
- Railways

- Wood treatment plants (pentachlorophenol)
- Antifoulant paint applicators (tributyltin).

Usage estimates for pesticides in the Puget Sound basin were compiled for each of these user categories by the following methods:

- Abstraction from published surveys of pesticide usage in Puget Sound counties.
- Telephone and letter surveys of current users in the basin.
- Extrapolation from published sources of pesticide usage for the San Francisco Bay area. These latter data are for urban pesticide usage only, and supplement data from limited surveys of local urban users.

These sources and cross-references for pesticide uses and chemical names are presented in Appendices A and B.

With the exceptions of pentachlorophenol (PCP) and railway pesticide usage, usage data are compiled by user category in each county in Appendix C. Estimated usage rates were highest for the major urban industrialized counties, Pierce and King, followed by the major agricultural counties, Snohomish, Whatcom, and Skagit.

Results of this usage summary indicate that over 2.8 million lb of pesticide active ingredients may be used annually throughout the Puget Sound basin. This estimate is equivalent to approximately 1 lb/person/yr. Over 120 active ingredients make up this total, and significantly more formulations and brand names are manufactured from the active ingredients used in the basin. This total includes 750,000 lb of PCP that are shipped to the basin for use in wood treatment plants and saw mills in the area. At present there are no pesticide manufacturers in the basin.

Total pesticide usage in the basin for 19 of the user categories (excluding wood treatment plants) is sorted into the following major categories:

- Urban - 1,075,800 lb/yr
- Military installations - 428,266 lb/yr
- Agriculture - 326,942 lb/yr
- Right-of-ways - 268,187 lb/yr
- Forestry - 21,037 lb/yr.

Urban use includes city government, commercial, and private household uses, and is the most diverse of these categories. For example, commercial uses include applications to nurseries, golf courses, private and commercial structures, school yards, and private yards and gardens. Military use includes Fort Lewis Army Base, McChord Air Force Base, and three Navy installations in the basin; agricultural usage includes private farms and state wildlife areas; right-of-ways comprise county, state and federal roadways, utilities, and railroads; and forestry includes private timber company and state forest lands.

Because data on current urban pesticide usage in the Puget Sound basin were nonexistent, urban usage estimates were initially attempted by surveys of local users. However, due to a lack of response to requests for usage information and the large scope involved in conducting surveys on multiple categories of urban users, urban usage estimates were derived by a combination of limited surveys and extrapolation from published usage data from California urban areas, particularly the San Francisco Bay area. Because of this method of data estimation, a large degree of uncertainty is inherent in the urban usage data. Assuming that, at worst, urban usage is overestimated by a factor of two, the data suggest a high use of pesticides in the urban sector. In comparison, forest uses are low in the Puget Sound basin. This latter finding reflects the temporary injunction issued in 1984 against pesticide use by the U.S. Forest Service. This injunction is expected to be lifted after the issue of an environmental impact statement by the U.S. Forest Service in late 1988. A ten-fold increase in forestry usage, however unlikely, would be necessary for forestry usage to have a major impact on total basin-wide pesticide usage.

To assess the spatial effects of potential pesticide migration into the aquatic systems of the basin and thence to the sound, pesticide usage is most appropriately presented on a watershed basis. Usages in six major watersheds (i.e., Nooksack, Skagit, West Sound, Elwha/Dungeness, Island, and San Juan) are assumed to be roughly approximate to their contiguous counties, whereas for the remaining watersheds (i.e., Snohomish, Stillaguamish, Cedar/Green, Puyallup, and Nisqually/Deschutes), data were extrapolated from county databases to the watershed by estimating the area of county land in the watershed and the pesticide usage of each user group on that land. Major watersheds of high pesticide usage (in descending order of usage) are the urban watersheds, Cedar/Green and Puyallup, the mixed economy watershed, Nisqually/Deschutes, and the agricultural watersheds of the Snohomish, Skagit, and Nooksack rivers.

DETERMINATION OF PESTICIDE LEVELS OF CONCERN

Determination of the level of concern for contemporary pesticides identified in the foregoing usage survey for the Puget Sound basin additionally involves characterization of their likely fate in the environment and toxicity to aquatic organisms. In general, the fate of most pesticides in the environment is dependent on their persistence in the soil and water and their potential to migrate away from the site of application. Persistence and mobility are dependent on the physical and chemical properties of the pesticide and the physico-chemical and microbiological environment of the soil. Hence, soil residence time and half-life, hydrolysis half-life, photolysis half-life, and vapor pressure are compiled as measures of persistence in the environment. Water solubility and soil adsorption (K_{OC}) are summarized as indices of mobility potential. Measures of bioaccumulation potential are bioconcentration factors (BCFs) and, when BCFs are not available, octanol-water partition coefficients (log K_{ow}). Data are similarly compiled on pesticide toxicities to freshwater and marine fish, marine shrimp, and mammals.

The algorithm to determine the level of concern involves assigning threshold levels for each of these variables, based on U.S. EPA recommendations, that delimit the potential for pesticides to persist in the environment, migrate to aquatic systems, bioaccumulate, and pose a toxic threat to aquatic organisms. Each pesticide is evaluated by these thresholds and for their level of usage in the basin. Pesticides are then ranked using these evaluations, and assigned to one of four levels of concern for Puget Sound: primary, secondary, low, and uncertain. Those pesticides with high usage, high mobility, high persistence, and high acute aquatic toxicity are assigned to the primary level of concern. Pesticides with lower mobility and/or persistence are placed in the secondary or low level of concern. These pesticides include those with high toxicity that are of concern primarily during acute exposures. Those pesticides for which data are insufficient to evaluate are placed in the uncertain level. Pesticides are further identified for their potential distribution among water, sediments, or biota of the basin, and with respect to concern for toxicity and fate of their identified metabolites.

Pesticides identified as being of primary concern in marine or riverine waters of the Puget Sound basin are 2,4-D, dicamba, arachlor, tributyltin (TBT), bromacil, atrazine, triclopyr, carbaryl, and diazinon. Pesticides with potential concern in sediments of the basin are identified as 2,4-D, dicamba, pentachlorophenol, prometon, simazine, tebuthiuron, chlorpyrifos, TBT, atrazine, diuron, trifluralin, phorate, pronamide, fenvalerate, and diazinon. Pesticides identified as primary concern for potential accumulation in biological tissues of the marine environment are trifluralin, chlorpyrifos, pentachlorophenol, fenvalerate, pronamide, diuron, dicamba, and TBT. An additional 32 pesticide active ingredients are identified as being of secondary concern in the Puget Sound basin.

CURRENT RESEARCH AND MONITORING PROGRAMS, AND RECOMMENDATIONS FOR FUTURE SURVEYS

A number of research programs are being conducted on pesticides in the Puget Sound basin that address their aquatic toxicity and/or their potential for contaminating the estuaries of Puget Sound. However, few programs in the basin have investigated ambient concentrations or potential nontarget effects of contemporary pesticides in the sound. A Huxley College (Western Washington University) program is focusing on pesticide contamination in Padilla Bay. Of fourteen pesticides known to be used in the vicinity of the bay, 2,4-D and dicamba have been detected in the water column and sediments of the bay after a period of rainfall following the prime application period of late spring. This sampling schedule was designed as a worst-case application run-off scenario. Ongoing monitoring programs (e.g., U.S. EPA, NOAA, Ecology) that sample for pesticide contamination were generally found to omit contemporary pesticides in their sampling protocol. Because of heavy usage and potentially high persistence and acute toxicity of certain pesticides in the basin, a reconnaissance survey is recommended for sampling the aquatic environments in the basin to determine the actual extent of pesticide contamination.

An initial reconnaissance survey in the basin should focus at a minimum on the pesticides of primary concern that are listed above. Areas of high urban use, as found in King and Pierce Counties, and high rural use, as found in Snohomish, Skagit, and Whatcom Counties, should be included in any reconnaissance sampling plan. In addition, spatially localized "hot spots" (i.e., military installations) and temporary intense periods of high use should be considered. It is recommended that sampling for specific pesticides be conducted at the outfalls of the major drainages of agricultural watersheds (Skagit and Snohomish Rivers); major urban areas (Seattle, Tacoma); the military installations of Fort Lewis, McChord Air Force Base, and Whidbey Island Naval Air Station; and of agricultural and right-of-ways in Mason, King, and Pierce counties. Because of seasonal application patterns with most pesticide uses, it is recommended that a sampling effort be conducted after the primary use season in June, before and after heavy rainfall to monitor a potential worst-case contamination scenario.

1.0 INTRODUCTION

This report synthesizes information on the usage and potential environmental effects of pesticides applied in the Puget Sound basin. The focus is on identifying potential problem pesticides that may migrate to Puget Sound and have an adverse effect on the estuarine ecosystem. A variety of pesticides is used in the Puget Sound basin to control pest organisms. Many of these pesticides are toxic to marine and freshwater organisms, and their active ingredients or degradation products may be highly persistent in the environment. However, little quantitative information is available on either the extent and distribution of contemporary pesticide use in the basin or the potential of these chemicals to produce adverse effects on estuarine ecosystems. Preparation of this document was initiated by U.S. EPA Region X to begin to address some of these deficiencies. It is anticipated that the results of this report will form the basis of a sampling plan for a U.S. EPA reconnaissance survey of potential problem pesticides in the estuarine environment of the basin.

1.1 OBJECTIVES

The primary objectives of this report are to evaluate the pesticides used in the Puget Sound basin and assign each pesticide a relative level of concern for their potential to contaminate aquatic environments. Major criteria that were used to determine the level of concern for a pesticide are the extent and locations of its usage, its ability to persist and be transported to the aquatic environment, and its potential acute and chronic toxicity to aquatic organisms. Previous assessments of the quantitative and spatial uses of contemporary pesticides in the Puget Sound basin were found to be insufficient to meet the stated objectives. Therefore, a secondary objective of this project has been to estimate the amounts and distribution of pesticides presently used in each of the 12 counties of the basin.

Current regulations and issues in pesticide use in the Puget Sound basin are briefly reviewed. Pesticides and their major uses are identified and quantitative usage values for each pesticide are estimated for the basin by county and watershed. For each of these pesticides, environmental fate and toxicity data are compiled. Along with usage data, these data form the basis for an evaluation of the relative potential of each pesticide to persist and migrate to riverine and marine environments in the basin. Geographical areas and media of potential contamination around the basin are identified. Ongoing research and monitoring programs for contemporary pesticides in the Puget Sound basin are identified and briefly described. Finally, a sampling strategy is recommended based on the level of concern of each pesticide and its breakdown products, and on the medium and likely geographical areas of contamination. Appendices are provided that contain sources of information on pesticide target organisms, usage, environmental fate, and toxicity; pesticide chemical names, tradenames, and names of manufacturers; county-wide pesticide usage data; a brief review of trends in pesticide uses and issues of environmental concern of select pesticides; and algorithm scores for the level of concern matrix.

1.2 PESTICIDE DEFINITIONS AND REGULATIONS

Pesticides are defined as insecticides, herbicides, rodenticides, fungicides, molluscicides, disinfectants, wood preservatives, repellants, or any other substance or mixture of substances intended for preventing, destroying, repelling, or mitigating organisms that are injurious to health or the environment. Repellants include those chemicals that repel, but do not kill, insects, birds, and small mammals. Although classified as "inert" ingredients, additives to pesticide formulations that act as solvents, thickeners, propellants, stabilizers, etc., include both nontoxic and toxic substances, ranging from sugar and salt to dioxane and formaldehyde. However, according to Section 10 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the identity of "inerts" and their percent composition of pesticide formulations are not required of pesticide manufacturers. These "inert" ingredients are not considered to be pesticides per se in this study because of the lack of available information on their use, composition, and environmental fate. It is estimated that of the over

1,200 substances classified as inert ingredients by U.S. EPA, two-thirds are insufficiently evaluated for toxicity [U.S. General Accounting Office (U.S. GAO) 1986].

Pesticides are currently regulated by U.S. EPA under FIFRA (Public Law 80-104). This law was enacted in 1947 to replace the 1910 Insecticide Act, and requires product labels containing instructions for use and warning statements about the potential health environmental effects of the product. FIFRA has been amended several times to include requirements for chronic health effects data and to create new criteria for pesticide registration. The amendments of 1972 placed added emphasis on protection of the environment by requiring the determination that the pesticide would not cause ". . . unreasonable adverse effects on the environment." The burden of proof that a pesticide meets the standards for registration is on the manufacturer.

The 1972 amendments to FIFRA also directed U.S. EPA, who was assigned responsibility for pesticide registration in 1970, to reassess and reregister existing pesticides in accordance with the new criteria. Under the Registration Standards Program begun in 1978, U.S. EPA began reviewing the approximately 600 existing pesticide active ingredients by examining five major areas: product chemistry, residue chemistry, environmental fate, wildlife effects, and toxicology. Toxicology studies cover mammalian exposures and chronic effects (e.g., carcinogenicity, reproductive effects). When new information suggests that a pesticide may pose a significant risk to human health or the environment, it is subjected to the Special Review process, begun in 1975, in which U.S. EPA decides to register, cancel, suspend, or modify the terms of registration. To accelerate the collection of data needed for reregistration, the Data Call-In Program was created in 1981 to identify chronic toxicity tests missing from the U.S. EPA pesticide registration files. Of the approximately 600 pesticide active ingredients, over 400 were still awaiting interim registration standard development as of March 1986, and 118 were either in the process of registration (89), ready for final standard review (17), or in Special Review (12) (U.S. EPA 1987c). The current session of Congress (100th) has been working on a revision of FIFRA. As of September 1988, noncontroversial areas have been revised, but the sections covering indemnification, storage/disposal, and registration fees have yet to be adopted.

U.S. EPA priority for reregistration has been given to pesticides used on food crops. The reregistration process for nonagricultural use pesticides, such as those used in urban areas, is expected to take 20 yr. In the interim, FIFRA provides that current registrations will remain in effect. Since the U.S. Department of Agriculture (USDA) concentrated on acute human health effects during the years it was responsible for pesticide registration (pre-1970), relatively little information is available on acute and chronic environmental effects of pesticides. It is toward these concerns that U.S. EPA is focusing its attention during reregistration.

Washington State pesticide laws (RCW 15.58 and RCW 17.21) are administered by the Washington State Department of Agriculture (WSDA) and include spray adjuvants as pesticides. WSDA restricts certain pesticide use in the state beyond U.S. EPA restrictions. According to the Washington Administrative Code (WAC 16-228), pesticides that are not allowed for distribution to home or garden users, but are allowed to be used by commercial applicators or government agencies, include dinitro-O-sec-butylphenol (DNOSBP), endothall, Ethion^{TM} (26 percent or greater), Guthion^{TM} (16 percent or greater), hydrogen cyanide, methyl bromide, and strychnine and its salts. Pesticide dealers are required to keep records of the sales of any of these pesticides. "State restricted use pesticides" are to be used only by certified applicators, and include Azodrin^{TM} (monocrotophos), Bidrin^{TM} (dicrotophos), DDT, DDD, DiSyston^{TM} (disulfoton, liquid) endrin, parathion, methyl parathion, Phosdrin^{TM} (mevinphos), sodium arsenite, Systox^{TM} (demeton), Temik^{TM} (aldicarb), TEPP, Thimet^{TM} (phorate, liquid), 2,4-D (liquid formulations, 1 gal or larger, distributed east of the Cascades, and all dry formulations except those labelled for home and garden use only), zinophos, and all pesticide formulations labelled for application to control pests in water, except for use in swimming pools, ornamental ponds, fountains, aquariums, enclosed plumbing systems, enclosed food processing systems, air conditioners, and cooling towers. Licensed dealers are required to keep records of all sales of state restricted-use pesticides for 1 yr. Highly volatile esters of 2,4-D are not registered by WSDA for use in Washington State.

1.3 PERSPECTIVES ON CURRENT AND HISTORICAL PESTICIDE USE IN THE PUGET SOUND BASIN

Puget Sound is one of the major estuarine systems in the continental United States, and its watershed basin supports the economic and commercial center of the Pacific Northwest. For the purposes of this report, the Puget Sound basin constitutes the 12 counties that border the sound itself, the Strait of Juan de Fuca up to the Elwha River, and the Strait of Georgia to the Canadian border (Figure 1). The major drainage basins within greater Puget Sound are shown in Figure 2.

There is a rich diversity of industries in the basin, and the major pesticide use categories reflect this division. These categories may be grouped by economy and geography into 1) major agriculture areas in the northeastern section of the basin; 2) forestry industry, concentrated in the southwestern section and along periphery of the basin; and 3) industrialized and populated urban areas. This diverse economic base results in the use of many different chemical pest control measures. Agricultural pesticides are used in preemergence control of unwanted vegetation and in control of crop-damaging pests. Forestry pesticides, primarily herbicides, are used by federal, state, and private timberland applicators to manage invading vegetation. Urban pesticides are used by a broad and diverse group of public, commercial, and household applicators for an equally diverse set of purposes. Most of these pesticide user groups (i.e., agricultural, forestry, urban) may be identified in each of the 12 Puget Sound counties.

The historical use of pesticides in the Puget Sound basin is largely unknown, and it is assumed that usage patterns followed nationwide trends. The use of inorganic compounds of relatively low toxicity as pesticides of choice changed dramatically after World War II with the advent of DDT and other organochlorine pesticides. However, as their toxicity to certain wildlife species and long persistence in the environment (measured in years to decades) became recognized by scientists and the public alike, U.S. EPA

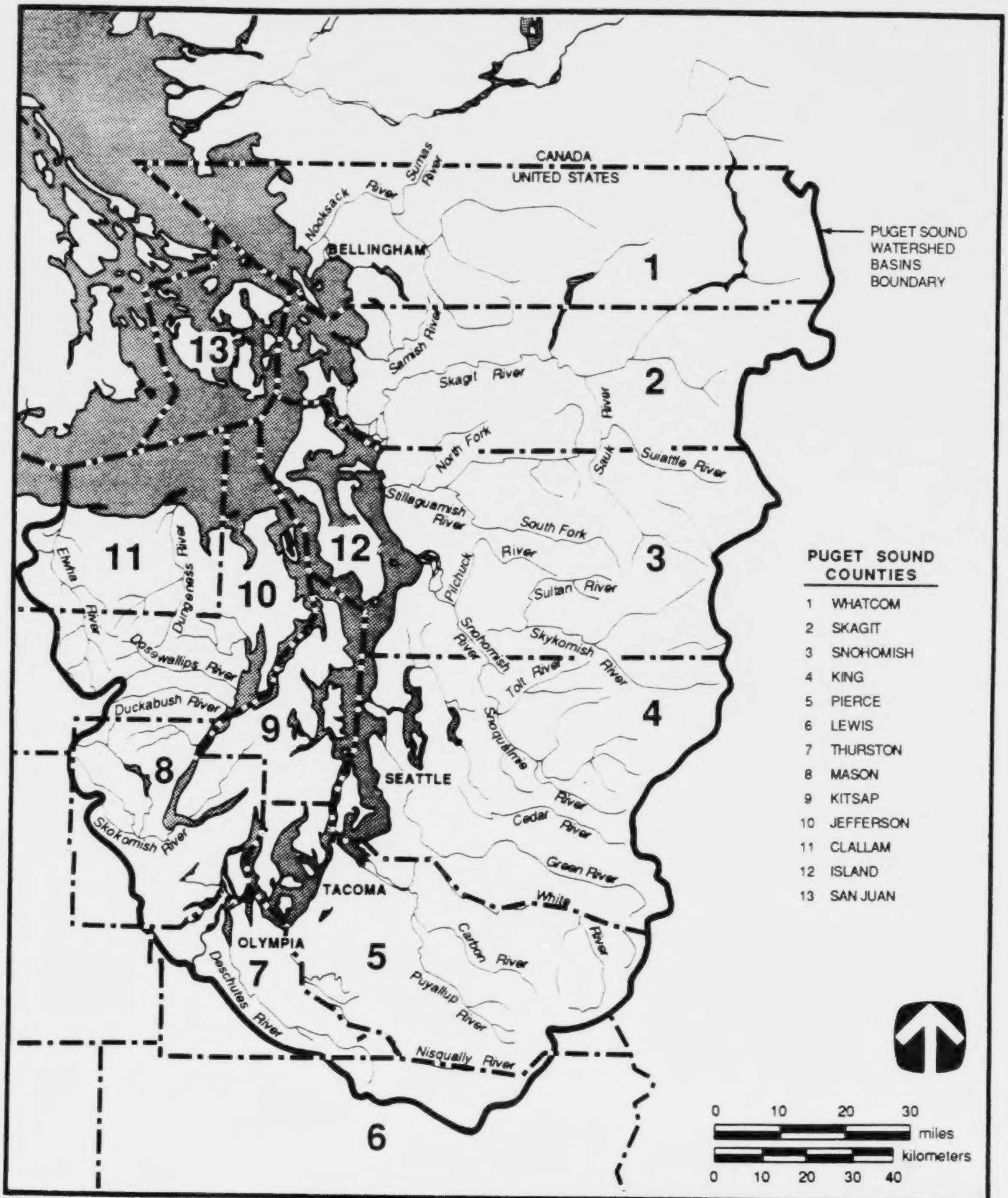
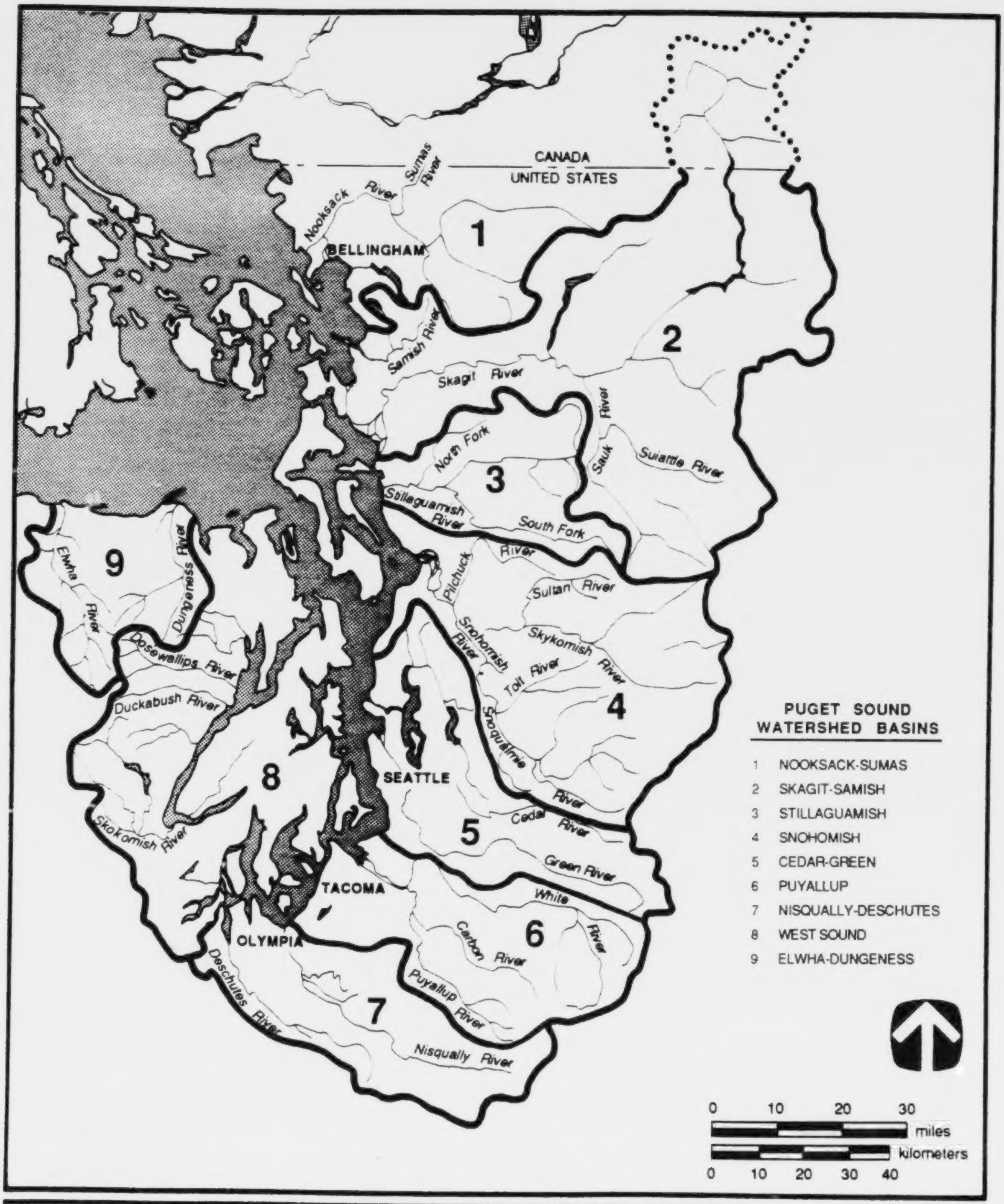

CANADA
UNITED STATES
PUGET SOUND WATERSHED BASINS BOUNDARY
BELLINGHAM
SEATTLE
TACOMA
OLYMPIA
1
2
3
4
5
6
7
8
9
10
11
12
13
Nooksack River
Sumas River
Samish River
Skagit River
Sauk River
Suiattle River
North Fork
Stillaguamish River
South Fork
Pilchuck River
Sultan River
Snohomish River
Skykomish River
Tolt River
Snoqualmie River
Cedar River
Green River
White River
Carbon River
Puyallup River
Nisqually River
Deschutes River
Skokomish River
Duckabush River
Dosewallips River
Dungeness River
Elwha River
PUGET SOUND COUNTIES
1 WHATCOM
2 SKAGIT
3 SNOHOMISH
4 KING
5 PIERCE
6 LEWIS
7 THURSTON
8 MASON
9 KITSAP
10 JEFFERSON
11 CLALLAM
12 ISLAND
13 SAN JUAN
0 10 20 30 miles
0 10 20 30 40 kilometers

Figure 1. Washington counties bordering Puget Sound.


CANADA
UNITED STATES
Nooksack River
Sumas River
BELLINGHAM
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North Fork
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Stillaguamish River
South Fork
Pilchuck River
Sultan River
Snohomish River
Skykomish River
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Elwha River
Dungeness River
Dosewallips River
Duckabush River
8
SEATTLE
Cedar River
5
Green River
Skokomish River
TACOMA
White River
6
Carbon River
OLYMPIA
Puyallup River
7
Deschutes River
Nisqually River
PUGET SOUND WATERSHED BASINS
1 NOOKSACK-SUMAS
2 SKAGIT-SAMISH
3 STILLAGUAMISH
4 SNOHOMISH
5 CEDAR-GREEN
6 PUYALLUP
7 NISQUALLY-DESCHUTES
8 WEST SOUND
9 ELWHA-DUNGENESS
0 10 20 30
miles
kilometers
0 10 20 30 40

Figure 2. Major drainages of the Puget Sound basin.

restricted or banned most of their uses in the early 1970s. Although the actual extent of use of these pesticides in the Puget Sound basin prior to government restrictions is unknown, the significantly lower concentrations in sediments of Puget Sound compared with other estuarine environments of the west coast suggest that their use was probably less widespread in the Puget Sound basin (Matta et al. 1986). Because these chemicals are no longer used for pest control in the Puget Sound basin, they are referred to as "historical pesticides" in this report and are not included in the evaluation of pesticides of concern. However, because they are on the U.S. EPA priority pollutant list, they are continually monitored in the sound by state and federal agencies.

Little is known about contemporary pesticide use in the Puget Sound basin. As of 1986, there was no comprehensive national database of total pesticide usage estimates and none were under development (GAO 1986). The State of Washington does not have any protocols in effect for the compilation or assembly of pesticide use data by any of the major user groups (Maxwell, T., 22 January 1988, personal communication), and no individual organization has compiled information on total pesticide usage in the basin. Although surveys of pesticide use by federal government agencies and agriculture in the U.S. and Washington State have been conducted, little effort has been devoted to assessing the extent of contemporary pesticide usage by all users in the Puget Sound basin.

The need for this information has recently been emphasized by the Committee on Research in Puget Sound (PSWQA 1988), who reports that there is severely limited quantitative information on the magnitude of nonpoint sources of contamination, such as agriculture and forestry, in the Puget Sound basin. Also, although the extent of "historical pesticide" contribution to point source pollution is being identified by sampling of urban embayments by U.S. EPA and Ecology, a better understanding of the potential contribution of contemporary pesticides to chemical contamination in Puget Sound is needed. This report contributes to that understanding by providing information on estimates of current pesticide usage in the Puget Sound basin, and by evaluating the relative concern for contamination of aquatic environments in the basin by these pesticides.

2.0 IDENTIFICATION OF PESTICIDES OF CONCERN

2.1 OVERVIEW OF APPROACH

The major objectives of this project are to ascertain the extent and general locations of pesticide usage throughout the Puget Sound basin and to develop a rank-ordered list of pesticides of concern in the basin. These objectives were accomplished by first defining categories of pesticide uses, sources of available information, and, where information was not available, indirect methods for estimating pesticide usage in the Puget Sound basin. The various sources of pesticide information were surveyed to determine the kinds and quantities of pesticides used on a county-wide basis and for major Puget Sound watersheds. Information was then collated from a variety of sources to characterize the environmental fate and toxicity of pesticides and certain pesticide metabolites. Finally, a tiered scoring method, which was based on usage, fate, and toxicity information, was used to rank pesticides and to determine the level of concern for pesticides in the Puget Sound basin.

The meaning of the term "usage" in this report is restricted to pesticide application rates; all usage data are for the active ingredients of the pesticide formulation. Pesticide "use" refers not to rates but to the types of applications, targets, and other dimensions of pesticide application.

2.2 SOURCES OF INFORMATION

Published pesticide usage surveys, telephone surveys, letter surveys, and data extrapolated from sources outside the geographical area were used to estimate pesticide usage in the basin. Sources of information on pesticide usage, environmental fate, and toxicity are listed in Tables A1-A4 of Appendix A. These lists include the literature, government agencies, and nongovernment organizations that were consulted. An initial attempt was made to contact the major distributors of pesticides in the Puget Sound area. Assuming that all pesticides sold in a given area are used and/or disposed of in that area, this information would have provided an accurate database on actual pesticide usage rates and locations in the basin with a relatively minimal extension of effort. However, because of their declination to participate in this project, this approach was not successful in acquiring usage information. In fact, one of the major vendors of pesticides to Washington State agencies estimated that the final usage values presented in this study may represent only one-half the actual total pesticide usage in the area (Huisenga, F., 5 January 1988, personal communication).

Compiled data on relative pesticide usage throughout the basin are lacking, since many pesticide user groups in the basin have not been surveyed previously for usage data. Additionally the few surveys that have been conducted are either 12 yr old and contain data for pesticides no longer in use, or lack quantitative data on a county-wide basis. These surveys include the household use surveys (von Rumker et al. 1972; Savage et al. 1980; Ridgley 1982) and a survey of commercial applicator use (Waddell et al. 1984). Compilations of pesticide usage by federal government agencies and agriculture are current (Freimark 1985; Gianessi 1986), except that local government agency use has not been surveyed. Because of deficiencies in data, a number of approaches for assessing pesticide usage in the Puget Sound basin were used. In general, the following data collection methods were used:

- Published surveys for federal government and agriculture pesticide usage

- Telephone and letter requests for usage information from most of the remaining user groups, when appropriate within the scope of the project

- For certain urban users, extrapolation from usage data available for comparable areas outside the Puget Sound basin.

These approaches and the sources of information are described in detail for each major pesticide user category identified in the Puget Sound area. Information on current patterns and projected trends in pesticide uses is presented in Appendix D.

The major pesticide user categories for which pesticide usage information is provided in this report are listed in Table 1. These categories comprise major pesticide users in the basin and biocides of particular interest to Puget Sound. Identification of the 20 user categories was based on suggestions from pesticide suppliers and representatives in state government agencies. Since the most readily available usage information was provided on a county-wide basis, this is the primary system for presentation of usage data herein.

2.2.1 Agriculture

Most data on pesticide usage by the agricultural sector of the Puget Sound basin were abstracted from a database compiled by Resources for the Future (RFF) (Gianessi 1986). RFF conducted a survey of national agricultural pesticide usage as a project for U.S. EPA, U.S. USDA, and the U.S. Geological Survey (USGS). The RFF database contains the most current information available on amounts and distributions of 20 pesticides used in agriculture throughout the country, on a county-wide basis. The database lists by common names the active ingredients of pesticides and omits solvents and banned chemicals.

The primary sources of data for RFF were various state, regional, and national surveys conducted by the Economic Research Service (ERS) of USDA (covering pesticide usage on 13 crops in 33 states). However, the State of Washington was not covered in the ERS survey. For data on crop acreage and estimated types of pesticides applied to each crop on a county-wide basis, the RFF database relied instead on a survey of pesticide contamination of vulnerable groundwater conducted for the U.S. EPA Office of Puget Sound (Sacha et al. 1986). Coefficients of pounds of pesticide applied per acre of crop per year (lb/ac/yr) and the percentage of crop acreage treated were provided by county Cooperative Extension agents and local farmers. Multiply-

TABLE 1. PESTICIDE USER CATEGORIES

- Agriculture
- Federal government agencies
  - Department of the Army
  - Department of the Air Force
  - Department of the Navy
  - Department of Agriculture
  - Department of the Interior
  - Department of Transportation
  - Department of Energy
  - Army Corps of Engineers
- State agencies
  - Department of Natural Resources
  - Department of Transportation
  - Department of Wildlife
- County road departments
- Urban users
  - Cities/school districts
  - Commercial applicators
  - Private households
- Private timber companies
- Railways
- Wood treatment plants (PCP)
- Antifoulant paint applicators (tributyltin)

ing the reported harvested acreage of Washington counties by the pesticide application coefficient provided an estimate of pesticide usage in lb/yr for 14 crops and 20 pesticides. This algorithm may be expressed as:

$$\begin{array}{ccccc} \text{Annual harvested} & & \text{Application} & & \text{Amount applied} \\ \text{acreage in Washington} & \times & \text{coefficient} & = & \text{per year} \\ (\text{ac/yr}) & & (\text{lb/ac}) & & (\text{lb/yr}) \end{array}$$

The total number of pesticides (20) reported by RFF for agricultural usage in the Puget Sound basin was considerably less than that estimated by U.S. EPA (Sacha et al. 1986). RFF chose pesticides to be representative of multiple chemical classes with a variety of applications, and for comparison with pesticide usage data nationwide. Therefore, RFF data were supplemented with pesticide usage data from the U.S. EPA database (Sacha et al. 1986). Application coefficients for these additional pesticides were derived from the California Annual Pesticide Report [California Department of Food and Agriculture (CDFA) 1986] by the following algorithm:

$$\frac{\text{Amount applied to California crop (lb)}}{\text{Acreage of application (ac)}} = \begin{array}{l} \text{California application} \\ \text{coefficient (lb/ac)} \end{array}$$

$$\begin{array}{ccccccc} \text{Application} & & \text{Percent of} & & \text{Total} & & \text{Amount applied} \\ \text{coefficient} & \times & \text{ac treated} & \times & \text{ac planted} & = & \text{per yr} \\ (\text{lb/ac}) & & (\text{percent}) & & (\text{ac/yr}) & & (\text{lb/yr}) \end{array}$$

Usage coefficients were calculated from data on the same crops used in the Puget Sound basin. Percentage of crop acreage treated with a particular pesticide was taken from either the RFF database or the Annual Pesticide Report (CDFA 1986).

2.2.2 Federal Agencies

Data on pesticide usage by the federal government was compiled from a U.S. EPA Region X survey (Freimark 1985). Most data are available by county or by specific site location. The survey concentrated on ". . . federal agencies most likely to use large quantities and/or potent types of pesticides." Agencies for which data were not provided by county were contacted by telephone and asked to provide county-wide information. Data cover the years 1982 to 1986 and were converted to pound of active ingredient per year. Pesticide active ingredients used in quantities less than 10 lb/yr were not included in the survey. For pesticide usage at military installations, all data were verified as actually used at each installation over a 1-yr period. U.S. Forest Service herbicide uses are discussed in Section 4.1.3. U.S. Department of Energy pesticide use primarily consists of applications to right-of-ways managed by the Bonneville Power Administration.

2.2.3 State Agencies

Washington State government contains a number of agencies that use pesticides either routinely or on a limited basis. There are no available surveys of pesticide use by the various state agencies, nor does the state government compile data on its agency-wide usage. Therefore, estimates of state agency usage were compiled from telephone interviews with authorities within the agencies.

Washington Department of Transportation (WDOT) does not maintain compiled records of pesticide usage, but retains only daily work records (3,500-5,000 annually). A search through these records was beyond the scope of this project. However, estimates of WDOT annual pesticide usage were obtained through the state Purchasing Division, Department of General Administration, which issues an invitation to bid to pesticide vendors for the sale of pesticides to WDOT on a 12-mo basis. The 1987 invitation to bid specified WDOT state locations for deliverables and quantities of pesticide formulations. Individual county usage of pesticide active ingredients was approximated from these state locations. Whether actual usage is reflected in the quantities in the bid is not known, and there is an uncertainty in actual spatial use of these pesticides, as highway locations of applications were not indicated. County WDOT usage data are therefore only estimates.

Pesticide usage in pounds of active ingredients (primarily herbicides) for Washington Department of Natural Resources (WDNR) in 1987 was provided by the Forest Land Management Division of WDNR on a county basis. These data include commercial aerial application only. It is estimated that WDNR crews apply another one-fifth of these quantities to WDNR lands (Belz, D., 25 January 1988, personal communication). Records of these in-house applications are not compiled by WDNR and data were not included in usage estimates.

Pesticide usage for the Washington Department of Wildlife (WDOW) wildlife areas was provided by the area managers during telephone interviews.

2.2.4 County Road Departments

Pesticide usage on right-of-ways in each of the counties was provided by each county department of public works, with the exception of Snohomish County, for which usages were estimated by comparison with neighboring counties. Jefferson, Mason, and San Juan counties do not use pesticides on county roads.

2.2.5 Urban Users

At present, there are no compilations of data on pesticide usage in Puget Sound urban environs, nor have national surveys been conducted with sufficient depth to adequately assess urban pesticide usage. The few published surveys addressing specific sectors of urban pesticide uses are discussed in each of the respective sections. Sources contacted for information include those listed in Tables A2-A4, and agencies, distributors, and retail outlets described below. For the purposes of this report, urban use has been divided into three categories: cities/school districts, commercial applicators, and private households. The urban land/vegetation and miscellaneous urban categories comprise all urban uses by certified commercial applicators.

2.2.5.1 Cities/School Districts--

Cities and school districts apply pesticides primarily to right-of-ways, parks, and school grounds. The availability of compiled data on pesticide usage by cities and school districts varied considerably among the municipalities of the Puget Sound basin. Some medium to large cities, notably Seattle, Olympia, Kirkland, Kent, Auburn, and Puyallup, were able to comply with requests for information for their pesticide usage. Most medium to small cities had difficulty abstracting this data from their records. Because so few cities responded to requests for information, and because the patterns of pesticides use was observed to differ greatly between large and small cities that did respond, it was necessary to base pesticide usage for the latter cities on data extrapolated from six cities and school districts in the San Francisco Bay area (Dreistadt et al. 1984; Bush 1986; Bush and Sweet 1987). Rationale and assumptions are discussed below. Average pesticide usage coefficients (lb/person/yr) were calculated using 1980 population statistics for the Puget Sound cities listed above and 1984 population statistics for the various cities in the San Francisco Bay area. These usage coefficients were multiplied by the population for each county in the Puget Sound area (see Table C1 in Appendix C) to estimate pesticide usage rates (lb/yr) for cities and school districts on a county-wide basis. The algorithms may be expressed as:

$$\frac{\begin{array}{c}\text{Amount applied per yr in}\\ \text{Puget Sound Basin and in}\\ \text{S.F. Bay area cities (lb/yr)}\end{array}}{\text{Population base (persons)}} = \begin{array}{c}\text{Usage coefficient}\\ \text{(lb/person/yr)}\end{array}$$

$$\begin{array}{c}\text{Usage}\\ \text{coefficient}\\ \text{(lb/person/yr)}\end{array} \times \begin{array}{c}\text{Population of}\\ \text{Puget Sound county}\\ \text{(persons)}\end{array} = \begin{array}{c}\text{Amount}\\ \text{applied per yr}\\ \text{per county}\\ \text{(lb/yr)}\end{array}$$

Data from the San Francisco Bay area were chosen as a source for extrapolation to the Puget Sound basin primarily because both of these areas surround a major estuarine system. Data were largely not available from other sources. Extrapolation from the San Francisco Bay area to the Puget Sound basin assumes that the pesticide usage rates, methods and purposes of application, and climate-specific pests are similar for the two metropolitan areas. To establish the accuracy and limitations of these assumptions, usage rates of pesticides for Puget Sound cities that responded to requests were compared with those from the San Francisco Bay area. The usage coefficients (lb/yr/person) were identical for some pesticides, within 20-50 percent of each other for two-thirds of the pesticides (randomly distributed), and different by a factor of 2-5 for a minority of pesticides. This latter difference is reflective of the high variability in usage data for the few cities of the Puget Sound basin for which pesticide usage data were available. Based on these findings, extrapolation from the San Francisco Bay area seems to be a reasonable approach for approximating pesticide usage for cities of the Puget Sound basin.

2.2.5.2 Commercial Applicators--

Commercial applicators are a diverse group of urban pesticide users. In the State of Washington, there are 23 different application license types (a total of 16,000 individual licenses in the state), ranging from landscape and golf course applications to building fumigation and water treatment. Of 600 licensed companies in the state, 231 are located within the 12 Puget Sound counties. These applicators have not been surveyed in the past for their pesticide usage, and a recent national survey by U.S. EPA on pesticide usage by commercial applicators (Waddell et al. 1984) focused on a few regions of the country rather than individual counties. These regions did not include the Puget Sound basin.

Pesticide usage by urban commercial applicators were estimated by a combination of Puget Sound usage coefficients and California usage coefficients. California commercial applicator pesticide usage data are available for 10 use categories (CDFA 1986); these categories were grouped into the urban land/vegetation or miscellaneous urban categories in the present report. Pesticide usage data in these two categories were calculated by slightly different methods. The urban land/vegetation category includes three State of Washington license types for applications to landscapes, yards, and nurseries. These licensed applicators are represented by the International Pesticide Applicators Association (IPAA) (Tovoli, P., 4 February 1988, personal communication). IPAA provided Puget Sound usage coefficients based on an average applicator license (lb/year/license) for 10 of the most commonly used urban pesticides in the Puget Sound basin, and names of nine pesticides of less use. Since the number of each type of license is not available from WSDA on a county-wide basis, usage coefficients based on population (lb/yr/person) were used in the calculations of usage.

These usage coefficients were calculated in two steps. First, an "initial usage coefficient" was derived from California data (CDFA 1986) for the pesticide of highest use in the basin (diazinon). Proportional usage coefficients per population for the remaining nine IPAA pesticides were then calculated from the California-based coefficients. The algorithms used in these calculations are as follows:

$$\frac{\begin{array}{c}\text{Amount of highest use}\\ \text{pesticide (diazinon) applied}\\ \text{in urban land/vegetation categories}\\ \text{in California per yr}\\ \text{(lb/yr)}\end{array}}{\begin{array}{c}\text{Population of California}\\ \text{(persons)}\end{array}} = \begin{array}{c}\text{"Initial usage coefficient"}\\ \text{or highest use pesticide}\\ \text{(lb/person/yr)}\end{array}$$

$$\frac{\begin{array}{c}\text{Individual usage coefficient}\\ \text{by license in Puget Sound basin}\\ \text{(supplied by IPAA)}\\ \text{(lb/license/yr)}\end{array}}{\begin{array}{c}\text{Highest usage coefficient}\\ \text{by license (from IPAA list)}\\ \text{(lb/license/yr)}\end{array}} = \begin{array}{c}\text{Proportional usage of}\\ \text{each pesticide}\\ \text{(unitless ratio)}\end{array}$$

$$\begin{array}{c}\text{"Initial usage coefficient"}\\ \text{for highest use pesticide}\\ \text{(lb/person/yr)}\end{array} \times \begin{array}{c}\text{Proportional}\\ \text{usage of each}\\ \text{pesticide}\end{array} = \begin{array}{c}\text{Individual usage}\\ \text{coefficient by}\\ \text{person in}\\ \text{Puget Sound basin}\\ \text{(lb/person/yr)}\end{array}$$

For the additional nine pesticides for which no license-based usage coefficients were provided, population-based usage coefficients were calculated from California data (CDFA 1986) as described in Section 2.2.5.1. The sum of usage values for pesticides for which IPAA provided licensed-based coefficients was estimated by IPAA (Tovoli, P., 4 February 1988, personal communication) to account for 75 percent of total pesticide usage in the urban land/vegetation category. Their usage coefficients were multiplied by 0.75 to reflect this difference. The usage coefficients for the remaining low-use pesticides, which lacked license-based coefficients, were multiplied by 0.25. Thus each pesticide was assigned a usage coefficient that reflected its proportional use by a representative IPAA member license. Each pesticide usage coefficient was then multiplied by the Puget Sound county populations to arrive at county-wide usage rates by the following algorithm:

$$\begin{array}{c} \text{Individual usage} \\ \text{coefficient by person} \\ \text{(lb/person/yr)} \end{array} \times \begin{array}{c} \text{Population of} \\ \text{Puget Sound county} \\ \text{(persons)} \end{array} = \begin{array}{c} \text{Usage in} \\ \text{each county} \\ \text{(lb/yr)} \end{array}$$

Commercial pesticide applicators in the second category (miscellaneous urban) are not represented by the IPAA, and usage information was not readily available from local commercial applicator companies. This category includes structural pest control, open urban area applications, golf course maintenance, and fumigation of stored commodity. Difficulties in obtaining usage information from the large structural pesticide applicator companies have been described by U.S. EPA (Waddell et al. 1984). In that study, personal contacts and interviews with industry leaders were necessary to acquire the desired usage information. Since telephone and letter requests failed to bring satisfactory information in the present study, usage data for this category were estimated by extrapolation from California pesticide usage data for equivalent categories (CDFA 1986). Pesticide usage coefficients (lb/yr/person) were calculated from California usage data (CDFA 1986), and these coefficients were multiplied by the Puget Sound county populations to arrive at pesticide usages per county. The following algorithms were used:

$$\frac{\begin{array}{c} \text{Amount used in California State} \\ \text{in miscellaneous urban categories (lb/yr)} \end{array}}{\begin{array}{c} \text{Population of California State} \\ \text{(persons)} \end{array}} = \begin{array}{c} \text{Usage coefficient} \\ \text{(lb/person/yr)} \end{array}$$

$$\begin{array}{c} \text{Usage coefficient} \\ \text{(lb/person/yr)} \end{array} \times \begin{array}{c} \text{Population of each} \\ \text{Puget Sound county} \\ \text{(persons)} \end{array} = \begin{array}{c} \text{Usage in} \\ \text{each county} \\ \text{(lb/yr)} \end{array}$$

Usages of less than 10 lb/yr for a particular pesticide were omitted from the data in both commercial applicator categories.

The final estimated usage rates for the commercial application categories in the Puget Sound basin entail certain limitations. Principally, extrapolation of data from California to the Puget Sound basin assumes that the number and sizes of application sites are similar between the two geographical areas. However, since the data were compiled from statewide usage data rather than a strictly urban population base, an accurate representation of urban usage in this category cannot be assumed. IPPA has also emphasized (Walter, E., 4 March 1988, personal communication) that certain pesticides may be substituted for one another by commercial applicators to control the same pest. In spite of these uncertainties, this method of usage estimation represents the best available within the scope of this project.

2.2.5.3 Private Households--

Private home usage includes total household usage as performed by the resident, including indoor use and outdoor yard and garden applications. Published surveys of household pesticide use do not provide adequate information for the determination of current household pesticide usage practices in the Puget Sound basin. This type of use is difficult to assess for two main reasons: 1) use is typically not reported and 2) manufacturers change products and product names so frequently that accurate recordkeeping is extremely difficult (Environmental Assessment Team 1978). von Rumker et al. (1972) established national household usage rates, but the pesticides surveyed in 1972 were a much different group of chemicals than those used in households today and included some pesticides that have since been restricted in use. Those usage rates (von Rumker et al. 1972) were not used in this study. Instead, a method of extrapolation from California household usage data was used to estimate household usage in the Puget Sound basin.

This extrapolation method is described as follows. First, contemporary household pesticides were identified by surveying a local retail outlet (Ernst Home and Nursery). Pesticide active ingredients were then rank-ordered for relative usage. The rank ordering was based on a comparison of three recent qualitative surveys of household pesticide uses (Savage et al. 1980; Ridgley 1982; Dewell 1987) and a conference with a specialist in retail pesticide sales in the Seattle area (Lou, L., 9 February 1988, personal communication). Usage coefficients (lb/person) were then calculated for each pesticide from California data (CDFA 1980) as described above for the miscellaneous urban sector of commercial applicators (see Section 2.2.5.2), using the most recent report (1980) in which pesticide manufacturers separated household pesticide usage data from other pesticide data (Hall, T., 1 March 1988, personal communication). Finally, usage coefficients were adjusted where necessary to fit the qualitative pesticide rankings and multiplied by county populations in the Puget Sound basin as described above to give estimates of county-wide household pesticide usage data. The final values for household pesticide usage therefore reflect the current rankings of sales by volume at a Seattle retail outlet and as reported for Seattle in 1982 (Ridgley 1982) and are as accurate as possible given the uncertainties of the methods. The assumptions concerning comparisons between two different urban populations that were discussed in previous sections apply to these estimations also. Further discussion of the extent of household use of pesticides nationwide and potential factors involved in household pesticide migration to the aquatic environment is provided in Appendix D.

2.2.6 Private Timber Companies

Timberlands in the Puget Sound basin are managed by three major groups. Two of these groups (U.S. Forest Service and WDNR) are discussed above. The remaining timberlands are held primarily by private timber companies. Their pesticide usage has not been surveyed, nor is their usage recorded by any government agency. Telephone interviews and letters of request were therefore initiated. Thirteen timber companies with holdings in the basin were solicited for information, but most declined to participate in the project. The five that responded with county-wide usage information included the two firms estimated to have the largest holdings, Weyerhaeuser Forest Products Co., and Champion International Corp. Data presented in the private timber category are for only those companies that participated in the study. For the remaining companies, the extent of their holdings in the basin and the percentage of these acres treated each year are not readily estimable. For these reasons, the data presented reflect substantial underestimates of actual usage.

2.2.7 Railways

Railroads have large right-of-way holdings throughout the Puget Sound basin, with most acreage concentrated in the east side of the sound in the urban/industrial counties, Pierce and King, and less acreage in Thurston County and the agricultural counties of the north basin. Only herbicides are applied to these areas.

Although approximately eight private and public railroad companies have right-of-ways in the basin (Harder, G., 18 May 1988, personal communication), 95-99 percent of herbicide application is by two companies, Burlington Northern (BN) and Union Pacific (UP) (Johnston, D., 25 May 1988, personal communication). Of these, BN holds most of the right-of-ways. Herbicide applications by these two companies are contracted to out-of-state commercial applicators. Records of these applications are not compiled by the railroad companies, and are only available from the applicators on a region-wide basis that encompasses most of the western U.S. (Ostrander, V., 6 June 1988, personal communication). Herbicide usage data for BN (Telesz, G., 8 August 1988, personal communication) and for UP (Johnston, D., 25 May 1988, personal communication) right-of-ways are included in Table 3 under the heading "basin-wide" but are not included in the county data tables (Appendix C).

2.2.8 Wood Treatment Plants

In this report, the wood treatment use category consists solely of pentachlorophenol (PCP), although creosote and inorganic arsenicals (primarily chromated copper arsenate) are also widely used. According to the sole manufacturer of pentachlorophenol in the U.S., approximately 720,000 lb of PCP were sold in the Puget Sound basin in 1987 (Lindsay, D., 8 February 1988, personal communication). A brief review of PCP users in the Puget Sound basin and trends in nationwide use is provided in Appendix D.

2.2.9 Antifoulant Paint Applicators

Tributyltin (TBT) is the major organotin compound in marine antifouling paints. However, cuprous oxide, in general, accounts for 90 percent of marine antifouling compounds. The Municipality of Metropolitan Seattle (Metro) reported TBT and cuprous oxide usage estimates for the Seattle area (King County) in a survey of major distributors of marine paints (Gamponia, V., 13 December 1985, personal communication). Buying agents for these distributors indicated that 1,200-2,000 gal of organotin-based antifouling paints were sold in Seattle in 1985. These figures were confirmed for 1987 by telephone survey (Haafs, D., 2 February 1988, personal communication).

The U.S. Navy is a major user of marine paints in Puget Sound, with a major shipbuilding facility in Seattle and a ship maintenance facility in Bremerton (Puget Sound Naval Shipyard). The former facility contracts with private paint applicators, and the latter facility uses U.S. Navy personnel for maintenance painting (Caps, J., 25 January 1988, personal communication). However, since the U.S. Navy is not at present using organotin-based marine paints during shipbuilding (Keiffer, R., 26 January 1988, personal communication) or during maintenance (Samford, J., 18 March 1988, personal communication), these sales figures are considered to be accurate reflections of total quantities of tin-based paints sold in 1985 in King County.

By using a conversion factor for content of TBT in these paints, which was supplied by one of the major manufacturers of TBT-based marine paints (Haafs, D., 2 February 1988, personal communication), these usage figures were converted to pounds of TBT. Usage estimates for the counties in the Puget Sound basin were extrapolated from the population base of King County, assuming the same volume of use of marine-based paints on a solely per capita basis. A brief review of the use of TBT and cuprous oxide as antifoulants in marine paints and the September 1988 regulatory status of TBT in U.S. EPA and the State of Washington is provided in Appendix D.

2.3 PESTICIDE USAGE

A wide variety of pesticides were identified as potentially used in the Puget Sound basin, and the active ingredients, trade names, and uses are listed in Table 2. The status of each pesticide in the Special Review process, where known, is also included in Table 2. The Special Review process is explained above in Section 1.2. A cross-index of tradenames is provided in Table B1 (Appendix B) for easy reference purposes. More detailed information on uses and intended targets of each pesticide is presented in Table B2 (Appendix B). Pesticides are listed by chemical classification for comparability of pesticidal activities between similar chemicals. Chemical names, chemical identification numbers (CAS numbers), and manufacturers names are provided in Table B3 (Appendix B). Sources for this information are listed in Table A1 (Appendix A) under Pesticide Compendia.

The previous section of this report identified pesticide user categories in the basin and methods for arriving at estimates of pesticide usage for each category. The present section compiles the results of those imputations for 12 counties and 9 major watersheds in the Puget Sound basin.

2.3.1 Estimated Usage of Pesticides in Puget Sound Counties

Compilation of county-wide data on pesticide usage by the user categories described above reveals that 122 pesticide active ingredients may be in current use in the Puget Sound basin. The data on the individual user categories (except wood treatment plants and railways) are shown by county in Tables C2-C13 (Appendix C). These tables present amounts that are estimated to be used, or surveyed as actually used, over a given 12-mo period in each of the defined use categories. As described in the previous section and later in the report (see Section 4.1), because of the limitations in data availability, pesticide usage data presented herein should be considered estimates of the lower bound of actual use. For example, total number of pesticides used in the basin is probably higher than reported due to the routine elimination of less frequently used pesticides (generally those used at less than 10 lb/yr) from published surveys (Gianessi 1986) and

TABLE 2. PESTICIDE NAMES AND CLASSIFICATIONS

	Active Ingredient	Uses	Classification	Synonyms*/Trade Names
1	2,4,5-T	Herbicide	Phenoxyaliphatic Acids	Weedar, Esteron, several
2	2,4-D	Herbicide	Phenoxyaliphatic Acids	Several
3	Acephate	Insecticide	Organophosphates	Orthene
4	Acrolein[a]	Herbicide	Miscellaneous Organics	Aqualin
5	Alachlor[a,c]	Herbicide	Anilides	Lasso
6	Aldicarb[a,c]	Insecticide/Acaracide	Carbamates	Temik
7	Aldrin[a,b]	Insecticide	Chlorinated Cyclodienes	Octalene
8	Aluminum Phosphide	Insecticide	Inorganics	Al-Phos, Celphine, several
9	Aminopyridine	Avicide	Pyridines	Avitrol*
10	Amitrole[c]	Herbicide	Triazoles	Several, Amitrole-T*
11	Ammonium Sulfamate	Herbicide	Inorganics	Ammate
12	Atrazine[a]	Herbicide	Triazines	Aatrex, Drexel
13	Azinphos-methyl[a]	Insecticide	Organophosphates	Guthion
14	Bacillus Thuringiensis[a]	Insecticide	Microbial	Biotrol K, Dipel, Thuricide
15	Bendiocarb	Insecticide	Carbamates	Ficam, Tattoo
16	Benfluralin[a]	Pesticide	Anilines	Benefin*, Balan
17	Benomyl[a,d]	Fungicide/Bactericide	Benzimidazoles	Benlate, Tersan
18	Bensulide	Herbicide	Organophosphates	Betasan, Prefar
19	Boric Acid	Insecticide	Inorganics	Boracic acid*
20	Bromacil	Herbicide	Uracils	Hyvar
21	Bromoxynil[a]	Herbicide	Nitriles	Brominal, Buctril, Nu-Lawn
22	Butylate[a]	Herbicide	Thiocarbamates	Sutan
23	Cacodylic Acid[a,c]	Herbicide	Organic Arsenicals	Bolls-Eye, Broadside, Dimethylarsinic Acid*
24	Captafol[a,b]	Fungicide/Bactericide	Dicarboximides	Difolatan
25	Carbaryl[c]	Insecticide/Acaracide	Carbamates	Sevin
26	Carbofuran[a,c]	Nematicide/Insecticide	Carbamates	Furadan
27	Carbon Disulfide[a]	Insecticide/Acaracide	Miscellaneous Organics	Carbon Bisulfide*
28	Chloramben	Herbicide	Benzoic Acids	Amiben, Vegiben
29	Chlordane[a,b]	Insecticide	Chlorinated Cyclodienes	Octachlor, Termide
30	Chlorflurenol	Herbicide	Carboxylic Acids	Chlorflurecol*, Maintain, Multiprop
31	Chloropicrin	Insecticide/Fungicide	Miscellaneous Organics	Several, and with methyl bromide
32	Chlorothalonil[a]	Fungicide/Bactericide	Nitriles	Daconil, Bravo
33	Chlorpyrifos[a]	Insecticide	Organophosphates	Dursban, Lorsban
34	Chlorsulfuron	Herbicide	Triazines	Glean, Telar
35	Copper Naphthenate[a]	Fungicide	Inorganic-organics	Cuprinol, Troysan
36	Cuprous Oxide[a]	Pesticide	Inorganics	Copper Nordox*
37	Dalapon[a]	Herbicide	Halogenated Hydrocarbons	Dowpon
38	DCPA[a]	Herbicide	Benzoic Acids	Dacthal, Chlorthal-Dimethyl
39	Diazinon[a,d]	Insecticide	Organophosphates	Knox-Out, Spectracide
40	Dicamba[a]	Herbicide	Benzoic Acids	Banvel, Banex, Bush Buster
41	Dichlobenil[a]	Herbicide	Nitriles	Casoron
42	Dichloropropene[a,c]	Insecticide/Acaracide	Halogenated Hydrocarbons	D-D, Telone
43	Dichlorvos[a,c]	Insecticide	Organophosphates	DDVP*, Vapona
44	Dicofol[d]	Acaricide	Halogenated Hydrocarbons	Kelthane
45	Dieldrin[a,b,e]	Insecticide	Chlorinated Cyclodienes	Alvit, Dieldrex
46	Dinoseb[a,d]	Herbicide	Phenols	DNBP*, Dinitro, Vertac
47	Dioxathion	Insecticide/Acaracide	Miscellaneous Organics	Delnav, Deltic

TABLE 2. (Continued)

	Active Ingredient	Uses	Classification	Synonyms*/Trade Names
48	Diphenamid[a]	Herbicide	Substituted Amides	Dymid, Enide
49	Diquat	Herbicide	Bipyridyliums	Reglone, Weedol
50	Disulfoton	Insecticide/Acaracide	Organophosphates	Di-Syston
51	Diuron	Herbicide	Uracils	Karmex, Krovar
52	Dormant Oil[a]	Insecticide/Acaracide	Miscellaneous Organics	Volck Oils
53	DSMA[a,c,d]	Herbicide	Organic Arsenicals	Dimethylarsonic Acid*, Ansar 8100, Arrhenal
54	Endosulfan[e]	Insecticide	Chlorinated Cyclodienes	Thiodan
55	Endothall[a]	Herbicide	Miscellaneuos Organics	Accelerate, Desi-cate
56	Endrin[a,b,e]	Insecticide	Chlorinated Cyclodienes	Endrex
57	Fenamiphos[a]	Nematicide	Organophosphates	Nemacur
58	Fenthion	Insecticide	Organophosphates	Baytex, Entex, Tiguvon
59	Fenvalerate[a]	Insecticide	Pyrethrins	Pydrin
60	Ferbam[a]	Fungicide/Bactericide	Carbamates	Fermate
61	Fosamine Ammonium[a]	Herbicide	Organophosphates	Krenite
62	Glyphosate[a]	Herbicide	Organophosphates	Roundup
63	Heptachlor[a,b,e]	Insecticide	Chlorinated Cyclodienes	Drinox, Termide
64	Hexazinone	Herbicide	Triazines	Velpar
65	Iprodione[a,e]	Fungicide/Bactericide	Dicarboximides	Chipco 26019, Rovral
66	Lime Sulfur	Fungicide/Bactericide	Inorganics	
67	Lindane[a,d]	Insecticide/Acaracide	Halogenated Hydrocarbons	Gamma HCH*, several
68	Linuron[c,e]	Herbicide	Uracils	Lorox
69	Malathion[a]	Insecticide/Acaracide	Organophosphates	Cythion
70	Maleic Hydrazide[a,c]	Herbicide	Heterocyclic Nitrogens	MH (WSSA)*, MH-30
71	Mancozeb[a,c,d]	Fungicide/Bactericide	Thiocarbamates	Dithane M-45, Karamate
72	Maneb[a,c,d]	Fungicide/Bactericide	Thiocarbamates	Dithane M-22, Manzate
73	MCPP	Herbicide	Phenoxyaliphatic Acids	Mecoprop*, Propal
74	Mefluidide[a]	Herbicide	Miscellaneous Organics	Embark
75	Metaldehyde	Molluscicide	Miscellaneous Organics	Antimilace, Halizan, Metason
76	Metam[a,c,d]	Fungicide/Herbicide	Thiocarbamates	Vapam, Metam-Sodium*, Metham*
77	Methamidophos	Insecticide	Organophosphates	Monitor, Tamanox
78	Methomyl	Insecticide	Carbamates	Lannate
79	Methoprene[e]		Hormone	Alfosid, several
80	Methyl Bromide[a]	Insecticide/Acaracide	Halogenated Hydrocarbons	Bromo-Gas, Terr-O-Gas
81	Methyl Parathion[a]	Insecticide	Organophosphates	Folidol, Metacide
82	Methylene Chloride	Insecticide/Acaracide	Halogenated Hydrocarbons	
83	Metiram[c]	Fungicide/Bactericide	Thiocarbamates	Polyram-Combi, Polyram
84	Metolachlor	Herbicide	Anilides	Dual
85	Metribuzin[a]	Herbicide	Triazines	Lexone, Sencor
86	Mevinphos[a]	Insecticide/Acaracide	Organophosphates	Phosdrin
87	Monocrotophos[a]	Insecticide/Acaracide	Organophosphates	Azodrin
88	Monuron[b]	Herbicide	Uracils	Telvar
89	MSMA[a,c,d]	Herbicide	Organic Arsenicals	Methylarsonic Acid*, Ansar 529, Byeno
90	Naled[a,c]	Insecticide	Organophosphates	Dibrom
91	Napropamide[a]	Herbicide	Substituted Amides	Devrinol
92	Octyl bicycloheptene-carboximide	Synergist	Dicarboximides	Van Dyke 264
93	Oryzalin[a]	Herbicide	Substituted Amides	Surflan

TABLE 2. (Continued)

	Active Ingredient	Uses	Classification	Synonyms*/Trade Names
94	Oxadiazon[a]	Herbicide	Heterocyclic Nitrogens	Ronstar
95	Oxycarboxin	Fungicide/Bactericide	Benzimidazoles	Plantvax
96	Oxydemeton-methyl[a]	Insecticide/Acaracide	Organophosphates	Metasystox-R
97	Oxyfluorfenl	Herbicide	Miscellaneous Organics	Goal
98	Paraquat[a,c]	Herbicide	Bipyridiliums	Several, Weedol
99	Parathion[a]	Insecticide	Organophosphates	Niran, Penncap-E, several
100	PCNB (Quintozene)[d]	Fungicide/Bactericide	Phenols	Quintozene*, Terraclor
101	Pentachlorophenol[a,b,d]	Herbicide/Molluscicide	Phenols	Penta*, PCP*
102	Permethrin[a]	Insecticide	Pyrethrins	Ambush, Ectiban, Pounce, Pramex
103	Phenothrin	Insecticide/Acaracide	Pyrethrins	Multicide, Sumithrin
104	Phorate[a]	Insecticide	Organophosphates	Thimet
105	Picloram[a]	Herbicide	Pyridine-Carboxylic Acids	Tordon
106	Piperonyl Butoxide[a,c]	Synergist	Miscellaneous Organics	Butacide
107	Prometon[a]	Herbicide	Triazines	Pramitol
108	Pronamide[a,d]	Herbicide	Miscellaneous Organics	Propyzamide*, Kerb
109	Propetamphos	Insecticide	Organophosphates	Safrotin
110	Propham[a]	Herbicide	Anilines	IPC, Chem-Hoe*
111	Propoxur	Insecticide	Carbamates	Baygon
112	Pyrethrins[a]	Insecticide	Pyrethrins	Pyrethrum*, Pyrenone, Pyrocide
113	Resmethrin	Insecticide	Pyrethrins	Cross Fire, Synthrin, SBP-1382
114	Rotenone[a,c]	Insecticide	Botanicals	Cube*, Derris, Nox Fish, Chem Fish
115	Sethoxydim[a,e]	Herbicide	Miscellaneous Organics	Nabu, Fervinal, Poast
116	Simazine[a]	Herbicide	Triazines	Princep, Aquazine
117	Sodium Chlorate	Herbicide	Inorganics	Several
118	Sodium Metaborate	Herbicide	Inorganics	Monoborchlorate, Ureabor, Borax*
119	Sulfometuron-methyl	Herbicide	Pyrimidines	Oust
120	Sulfotep[e]	Insecticide/Acaracide	Organophosphates	Bladafum
121	Sulfur	Fungicide/Bactericide	Inorganics	Several
122	Sulfuryl Fluoride	Insecticide/Acaracide	Inorganics	Vikane
123	Tebuthiuron[a]	Herbicide	Uracils	Spike
124	Temephos	Insecticide	Organophosphates	Abate
125	Terbacil	Herbicide	Uracils	Sinbar
126	Thiram[a]	Fungicide/Bactericide	Thiocarbamates	Several, Aatack
127	TriButylTin[a,c]	Pesticide	Inorganic-organics	Several
128	Trichlorfon[a,c,e]	Insecticide/Acaracide	Organophosphates	Dipterex, Dylox, Neguvon, Proxol
129	Triclopyr	Herbicide	Pyridine-Carboxylic Acids	Garlon 3A, Garlon 4
130	Trifluralin[d]	Herbicide	Nitroanilines	Treflan, Terbalin
131	Vernolate[a]	Herbicide	Thiocarbamates	Vernam
132	Warfarin	Rodenticide	Coumarins	Coumafene, Zoocoumarin
133	Xylene	Additive	Miscellaneous Organics	Xylol
134	Zineb[a,e]	Insecticide/Acaracide	Carbamates	Aspor, Zineb, Dithane
135	Ziram[a,c,d]	Fungicide	Thiocarbamates	Ziram Tech.

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[a] Use-specific "Data Call-In" decision reached: data complete or being generated.
[b] Cancelled (voluntarily or by Notice of Intent) for all or most uses.
[c] Currently in Special Review or returned to registration process.
[d] Special Review completed.
[e] Usage in Puget Sound basin not known.

from extrapolated data reported herein. Furthermore, pesticide usage may be expected to increase in the basin after termination of the injunction against U.S. Forest Service usage (see Section 4.1.3).

Summarized data on nonurban pesticide usage (pounds of each pesticide used per year) are presented for each of the 12 Puget Sound counties in Table 3. Major urban use pesticides for which usage data were derived largely by extrapolation from other geographical areas are listed in Table 4. Pesticides are ranked by total usage in the basin, beginning with the pesticides of highest estimated usage. Total estimated pesticide usage in each county is presented in Table 5. These data are the summation of pesticide usage data from the 18 user categories in Appendix C (see Tables 3 and 4) and the data reported in a basin-wide basis in Table 3. It is estimated that more than 2.8 million pounds of pesticide active ingredients are used per year in the Puget Sound basin. This value is equivalent to approximately 1 lb/person. In comparison, total reported pesticide usage in California is more than 3 lb/person (CDFA 1986). This difference presumably reflects the extensive agricultural application in that state.

Estimated urban pesticide usage data in the Puget Sound basin, as noted in Tables 4 and C2-C13 (Appendix C), are based on a combination of Puget Sound data and extrapolation from California data. Because of this, there are major uncertainties about the usage rates for pesticides used in this category. Specifically, usage data for methyl bromide, sulfuryl fluoride, metaldehyde, and chlordane should be considered estimates only. In California, methyl bromide is used primarily as a fumigant in buildings, ranging from industrial sites to schools (Olkowski et al. 1980), sulfuryl fluoride is used solely against structural insects, chlordane is used primarily against building termites, and metaldehyde is a home pesticide for use on slugs and snails. Because these pesticide uses and targets may be more prevalent in California than in Puget Sound, their assigned level of concern presented in Section 2.5 reflects a high usage uncertainty. IPAA (Walter, E., 4 March 1988, personal communication) and other user groups have cautioned that these uncertain data by themselves should not be used for regulatory purposes by governmental agencies or for public decision-making.

TABLE 3. PESTICIDE USAGE IN THE PUGET SOUND BASIN EXCLUSIVE OF MAJOR URBAN-SPECIFIC PESTICIDES[a] (POUNDS OF ACTIVE INGREDIENT PER YEAR)

ACTIVE INGREDIENT	CLALLAM	ISLAND	JEFFERSON	KING	KITSAP	MASON	PIERCE	SAN JUAN	SKAGIT	SNOHOMISH	THURSTON	WHATCOM	BASIN WIDE[b]	TOTAL
Pentachlorophenol	0	0	0	0	0	0	0	0	0	0	0	0	720,000	720,000
2,4-D Species[c]	5,249	2,397	3,717	25,219	4,342	3,583	214,313	1,917	11,340	18,106	6,329	11,574	3,320	311,406
Malathion[c]	1,562	2,028	476	38,010	4,354	936	136,935	240	1,912	10,048	3,672	3,153	0	203,326
Prometon	90	80	30	28,324	281	13,023	20,382	15	6,581	7,107	235	32,596	0	108,744
Simazine[c]	144	188	42	19,708	868	50,083	11,494	13	1,184	9,681	1,266	2,612	0	97,283
Diazinon[c]	1,666	1,416	512	39,647	4,607	1,004	14,874	245	2,123	9,538	3,967	3,528	0	83,127
Dicamba[c]	225	1,387	68	19,246	1,640	2,325	15,106	25	5,096	6,089	637	3,602	0	55,446
Triclopyr	766	285	79	7,845	871	170	36,356	25	600	4,543	1,573	720	800	54,633
Atrazine[c]	17	396	0	18,328	2,000	80	3,387	0	4,389	3,101	1,651	3,582	7,460	44,391
Bromacil	0	14,397	240	323	321	28	15,097	0	174	140	10,014	83	0	40,817
Carbaryl[c]	773	564	242	14,150	1,589	394	5,484	87	4,991	4,550	1,412	3,061	0	37,297
Diuron[c]	113	13,758	400	5,374	1,045	1,095	3,478	0	803	2,712	1,167	305	6,870	37,120
Glyphosate[c]	782	481	422	11,889	1,267	299	9,209	59	1,089	5,722	1,583	2,286	0	35,088
Tebuthiuron	0	0	0	8,272	0	4,130	6,192	0	2,064	2,064	0	10,321	0	33,043
Vernolate	0	7	0	1,370	0	0	450	0	4,653	4,092	704	4,923	0	16,199
Cuprous Oxide	312	273	93	7,840	200	200	2,940	47	400	1,960	780	700	0	15,745
Dichloropropene	0	0	0	169	20	0	65	0	0	45	17	15,014	0	15,330
Parathion	290	105	96	1,366	99	70	621	2	6,968	2,108	131	1,890	0	13,746
Sodium Metaborate	14	12	0	334	39	0	13,123	0	17	89	33	28	0	13,689
Dinoseb[c]	112	55	17	1,500	164	34	922	0	4,828	1,219	201	3,340	0	12,392
Butylate	0	0	0	0	0	0	400	0	7,000	4,600	0	0	0	12,000
Alachlor	0	6	0	788	0	72	395	0	3,430	1,761	387	2,563	0	9,402
Phorate	0	0	0	450	3	18	27	0	3,316	1,425	174	2,743	0	8,156
Methyl Parathion	99	10	0	65	0	0	0	0	5,155	1,235	0	1,292	0	7,856
Lime Sulfur[c]	46	5,088	15	1,100	130	28	440	10	60	300	100	100	0	7,417
Disulfoton[c]	75	62	25	1,942	200	45	2,096	10	1,803	509	175	398	0	7,340
Methamidophos	0	0	0	21	3	0	0	0	3,917	80	3	1,952	0	5,976
Pronamide	0	3	0	352	0	4,000	620	0	500	200	0	175	0	5,850
Trifluralin	31	14	0	414	41	10	183	0	3,658	142	38	1,016	0	5,547
Oryzalin[c]	76	68	22	3,300	223	45	933	10	60	300	190	170	0	5,397
Metolachlor	0	0	0	334	2	9	22	0	2,257	776	94	1,807	0	5,301
Boric Acid[c]	80	69	25	1,975	229	49	1,151	12	100	525	614	166	0	4,995
Sulfometuron-methyl	176	64	30	1,218	153	103	863	0	305	1,212	146	442	210	4,922
Acrolein[c]	90	77	28	2,206	256	54	844	111	111	587	216	185	0	4,765
Fenvalerate	0	0	0	56	0	0	4,682	0	0	15	0	0	0	4,753
Benfluralin[c]	100	90	30	2,411	300	108	100	16	130	700	250	200	0	4,435
Diquat[c]	75	65	20	1,971	231	44	754	11	97	523	194	167	0	4,152
Propham	0	0	0	28	0	0	0	0	1,800	2,300	0	0	0	4,128
Methomyl	17	14	0	419	118	10	428	0	2,321	610	41	35	0	4,013
TriButylTin	134	117	40	0	385	85	1,260	20	170	840	335	300	0	3,686
Fosamine Ammonium	0	0	80	1,760	320	400	880	0	240	0	0	0	0	3,680
Hexazinone	0	0	0	0	320	0	2,012	0	0	0	0	260	0	2,592
Diphenamid	0	0	0	0	0	0	900	0	0	1,500	0	0	0	2,400
Pyrethrins	37	22	8	863	106	16	443	4	43	240	86	72	0	1,940

TABLE 3. (Continued)

ACTIVE INGREDIENT	CLALLAM	ISLAND	JEFFERSON	KING	KITSAP	MASON	PIERCE	SAN JUAN	SKAGIT	SNOHOMISH	THURSTON	WHATCOM	BASIN WIDE[b]	TOTAL
Terbacil	0	0	0	0	0	0	500	0	1,100	270	0	0	0	1,870
MSMA	35	31	0	869	101	13	330	0	42	230	83	73	0	1,807
Carbofuran	149	86	14	435	51	30	558	6	95	132	57	106	0	1,719
Temephos	0	0	0	18	0	0	0	0	0	0	0	1,700	0	1,718
Fenamiphos	0	0	0	100	0	0	600	0	250	650	0	0	0	1,600
Bendiocarb	22	18	0	631	62	13	388	0	27	141	230	45	0	1,577
Unknown Herbicide	0	0	0	0	0	0	1,400	0	0	0	0	0	0	1,400
Picloram	439	30	450	16	150	200	0	0	0	0	0	0	0	1,285
Oxadiazon	20	20	0	500	60	10	200	0	30	260	50	50	0	1,200
Piperonyl Butoxide	23	20	0	564	65	14	216	0	29	150	55	47	0	1,183
Captafol	0	0	0	2	0	0	9	0	636	16	0	443	0	1,106
Captan	20	18	0	507	60	12	190	0	25	135	50	40	0	1,057
Dalapon	0	0	0	0	900	40	0	0	0	0	0	0	0	940
Paraquat	18	15	0	447	52	11	171	0	23	119	44	38	0	938
Bensulide	0	0	0	6	0	0	11	0	864	0	0	0	0	881
Bacillus Thuringiensis	0	464	0	202	23	0	57	0	10	54	20	35	0	865
Dicofol	15	13	5	405	45	11	160	3	20	110	40	30	0	857
Cacodylic Acid	17	15	0	400	50	10	160	0	20	100	40	35	0	847
Phenothrin	0	0	0	0	0	0	753	0	0	0	0	0	0	753
Copper Naphthenate	15	12	0	357	41	0	137	0	18	95	35	30	0	740
Warfarin	0	0	0	0	0	0	735	0	0	0	0	0	0	735
Metiram	0	0	0	2	0	0	7	0	418	11	0	290	0	728
Chlorflurenol	15	13	0	300	40	9	150	0	20	100	30	30	0	707
Rotenone	10	10	4	280	30	7	200	2	15	75	30	25	0	688
Octyl bicycloheptenedi carboximide	13	11	0	315	37	0	12	0	16	84	31	26	0	545
Napropamide	20	10	0	219	20	5	100	0	10	50	20	50	0	504
Monuron	0	0	0	400	0	0	0	0	0	0	0	0	0	400
Methylene Chloride	0	0	0	188	22	0	72	0	10	50	18	16	0	376
Naled	0	0	0	179	21	0	68	0	0	48	17	15	0	348
Metribuzin	0	100	0	0	0	0	0	0	110	40	0	90	0	340
Monocrotophos	0	0	0	174	20	0	67	0	0	46	17	15	0	339
Thiram	0	0	0	38	0	0	254	0	0	10	0	0	0	302
Permethrin	0	0	0	151	16	0	54	0	0	38	14	12	0	285
Mevinphos	0	0	0	141	16	0	54	0	0	38	14	12	0	275
Bromoxynil	0	0	0	136	16	0	53	0	0	37	13	12	0	267
Mefluidide	0	0	0	125	15	3	50	0	0	30	12	10	0	245
Resmethrin	0	0	0	124	14	0	47	0	0	33	12	10	0	240
Chloramben	0	0	0	74	0	0	100	0	0	0	0	0	0	174
Chlorsulfuron	0	2	1	0	0	0	0	0	13	0	3	7	140	166
Fenthion	0	0	0	89	10	0	34	0	0	24	0	0	0	157
PCNB (Quintozene)	0	0	0	85	10	0	32	0	0	23	0	0	0	150
Dioxathion	0	0	0	80	0	0	32	0	0	21	0	0	0	133
Ammonium Sulfamate	0	0	0	67	0	0	26	0	0	18	0	0	0	111

TABLE 3. (Continued)

ACTIVE INGREDIENT	CLALLAM	ISLAND	JEFFERSON	KING	KITSAP	MASON	PIERCE	SAN JUAN	SKAGIT	SNOHOMISH	THURSTON	WHATCOM	BASIN WIDE[b]	TOTAL
Maleic Hydrazide	0	0	0	0	0	0	6	0	100	0	0	0	0	106
Aldicarb	0	0	0	0	0	0	0	0	0	0	0	100	0	100
Mancozeb	0	0	0	47	0	0	18	0	0	13	0	0	0	78
Maneb	0	0	0	47	0	0	18	0	0	13	0	0	0	78
DSMA	0	0	0	19	0	9	14	0	5	5	0	23	0	75
Aluminum Phosphide	0	0	0	45	0	0	17	0	0	12	0	0	0	74
Oxydemeton-methyl	0	0	0	52	0	0	0	0	0	0	0	0	0	52
Oxyfluorfen	0	0	0	28	0	0	11	0	0	0	0	0	0	39
Metam	0	0	0	0	0	0	22	0	0	15	0	0	0	37
Aminopyridine	0	0	0	0	0	0	30	0	0	0	0	0	0	30
Ferbam	0	0	0	0	30	0	0	0	0	0	0	0	0	30
DCPA	0	0	0	19	0	0	0	0	0	0	0	0	0	19
	13,982	44,484	7,231	279,470	28,704	82,947	537,984	2,890	99,591	116,590	39,350	120,776	738,800	2,112,799

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[a] Usage rates were determined primarily from national and local surveys

[b] County-specific usage not determinable. Includes use by wood treatment plants (PCP) and railways.

[c] Usage values include moderate urban use. Indicated only for those pesticides with total usage > 2,000 lb/yr and not listed in Table 4. Urban usage data were estimated by extrapolation from out-of-state data supplemented with local survey data. County-wide usage rates are provided for four urban categories in Appendix C.

TABLE 4. ESTIMATED USAGE OF MAJOR URBAN-SPECIFIC PESTICIDES IN THE PUGET SOUND BASIN[a] (POUNDS OF ACTIVE INGREDIENT PER YEAR)

ACTIVE INGREDIENT	CLALLAM	ISLAND	JEFFERSON	KING	KITSAP	MASON	PIERCE	SAN JUAN	SKAGIT	SNOHOMISH	THURSTON	WHATCOM	TOTAL
Methyl Bromide	5,300	4,500	1,600	130,600	15,100	3,200	50,000	800	6,600	34,700	12,800	11,000	276,200
Sulfuryl Fluoride	2,300	2,000	700	57,100	6,600	1,400	21,900	400	2,900	15,200	5,600	4,800	120,900
Metaldehyde	1,000	900	300	26,100	2,900	600	9,400	200	1,300	6,800	2,500	2,200	54,200
Chlordane	1,000	800	300	23,500	2,700	600	9,000	100	1,200	6,300	2,300	2,000	49,800
Chlorpyrifos	800	700	200	18,500	2,200	500	7,200	100	900	4,900	1,800	1,600	39,400
Sulfur	700	600	200	16,400	1,900	400	6,300	100	800	4,400	1,600	1,400	34,800
Xylene	400	400	100	10,200	1,200	200	3,900	100	500	2,700	1,000	900	21,600
Acephate	300	300	100	10,100	1,000	200	3,200	100	400	2,200	800	700	19,400
Ziram	300	300	100	8,300	1,000	200	3,200	100	400	2,200	800	700	17,600
Endosulfan	300	200	80	6,600	800	200	2,500	40	300	1,800	600	600	14,020
MCPP	200	200	60	5,400	600	100	2,000	30	300	1,400	500	500	11,290
Heptachlor	200	200	60	5,200	600	100	2,000	30	300	1,400	500	400	10,990
Amitrole	200	200	60	4,800	600	100	1,800	10	200	1,300	500	400	10,170
Azinphos-methyl	200	100	50	3,800	400	100	1,500	20	200	1,000	400	300	8,070
Propoxur	100	100	30	3,300	400	100	1,800	10	200	900	300	300	7,540
Dichlobenil	100	100	50	3,500	400	100	1,200	20	200	800	300	300	7,070
Benomyl	100	100	40	3,100	400	100	1,200	20	200	800	300	300	6,660
Chlorothalonil	100	100	40	3,000	100	100	1,100	10	200	800	300	300	6,150
Chloropicrin	100	50	20	1,800	200	40	700	0	100	500	200	100	3,810
Lindane	50	40	20	1,300	100	30	500	0	100	300	100	100	2,640
Dichlorvos	50	40	10	1,100	200	30	500	10	100	300	100	50	2,490
Propetamphos	50	40	10	1,100	100	30	400	0	50	300	100	100	2,280
	13,850	11,970	4,130	344,800	39,500	3,430	131,300	2,200	17,450	91,000	33,400	29,050	727,080

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[a] Includes those pesticides used primarily, if not solely, in the urban sector, and above 2000 lb/yr. Usage rages were estimated by extrapolation from usage data for a comparable urban area, supplemented with data from local surveys as described in Section 2.2.5.

TABLE 5. TOTAL ESTIMATED PESTICIDE USAGE IN THE PUGET SOUND BASIN[a]

County	Active Ingredients (lb/yr)
Clallam	27,832
Island	56,454
Jefferson	11,361
King	624,270
Kitsap	68,204
Mason	91,377
Pierce	669,284
San Juan	5,090
Skagit	117,041
Snohomish	207,590
Thurston	72,750
Whatcom	149,826
Basin-wide	738,800
Total	2,839,879

[a] Estimated county-wide annual usage rates are the sums of usage rates from surveys (Table 3) and rates that were estimated for urban usage (Table 4).

2.3.2 Pesticide Usage By Watershed

The Puget Sound basin is bounded by the ridges along the eastern (Cascade Mountains), southern (southern highlands), and western (Olympic Mountains) borders. The numerous drainages contained therein can be consolidated into nine major watersheds plus the San Juan Islands and Whidbey Island, as depicted in Figure 2. The sizes and natures of the major rivers differ markedly. The Skagit, Stillaguamish, and Snohomish rivers drain 50 percent of the basin and contribute 60 percent of the freshwater flow into Puget Sound (PSWQA 1986b). This water enters the sound in the Whidbey basin east of Whidbey Island. In contrast, the southern portion of the basin receives only 10 percent of the fresh water entering Puget Sound.

Although pesticide usage data in Appendix C (Tables C2-C13) and in the summary tables (see Tables 3 and 4) are presented on a county-wide basis, a more appropriate presentation of the data, for the purpose of designing a sampling program for these pesticides, is on a watershed basis. This type of presentation allows the identification.and localization of streams, rivers, and their outfalls in the basin that may be of concern for potential pesticide contamination. By visual inspection of county and watershed boundaries (see Figures 1 and 2), county pesticide usage data can be transferred as estimates of watershed usage directly from each of the following eight counties of the basin to their respective watersheds:

County	Watershed
Whatcom	Nooksack
Skagit	Skagit
Mason/Kitsap/Jefferson	West Sound
Clallum	Elwha/Dungeness
Island	Island
San Juan	San Juan

However, the boundaries of the remaining four counties (i.e., Snohomish, King, Pierce, and Thurston) have significant overlaps with Snohomish, Stillaguamish, Cedar/Green, Puyallup, and Nisqually/Deschutes watershed boundaries.

At present, there is no readily available map system designed for the direct transfer of these county data to a watershed basis in the Puget Sound basin (Reinhard, C., 15 January 1988, personal communication). To identify and quantify pesticide use in these watersheds, county pesticide usage data were reorganized by types of land uses and transferred to the respective watersheds draining those lands by the following approach.

Five major categories of pesticide usage were identified in the Puget Sound basin by regrouping and consolidating the 20 user categories originally identified in Table 1. These major categories are agriculture, forestry, urban use, military installations, and right-of-ways, and the original user categories that make up each of these are listed in the legend to Table 6. Based on this regrouping of user categories, pesticide usage data for each county in Tables C2-C13 were transferred to these five major categories, as presented in Table 6. Note that urban usage data in Table 6 include all urban data from Tables C2-C13, as compared with Table 4, which includes data for only major urban pesticides.

Four of these major categories, agriculture, forestry, urban, and military installations, represent localized uses and their approximate geographical locations of use were identified on Puget Sound basin "land use" maps (Environment Canada 1973). The fifth major category, right-of-ways, is widespread throughout the basin and nonlocalized, and therefore not identified on land-use maps.

In the four counties of interest, each 36-mi^2 township was located to its approximate watershed drainage using a "hydrologic unit" map of the Puget Sound basin (USGS 1974). The pesticide usage data of four of the major use categories (Table 6) that corresponded to each of these county land use parcels were then transferred to the same watershed as the land use parcel. For the right-of-ways category, usage data were transferred to watersheds as a percentage of total county land in each watershed.

These final usage data for the major use categories are presented for the five watersheds in Table 7. Because specific locations of pesticide usage cannot be identified from the data in Tables C2-C13, usage rates for

TABLE 6. ESTIMATED TOTAL PESTICIDE USAGE FOR MAJOR USE CATEGORIES[a]
(POUNDS OF ACTIVE INGREDIENTS PER YEAR)

County	Agriculture[b]	Forestry[c]	Urban[d]	Right-of-Ways[e]	Military Installations[f]
Clallam	4,075	2,181	20,700	985	0
Island	3,582	50	17,600	637	34,468
Jefferson	1,718	3,172	6,200	405	0
King	30,698	4,827	509,700	79,478	23
Kitsap	4,655	112	59,000	3,907	523
Mason	57,693	120	12,500	21,141	0
Pierce	27,302	6,156	194,100	48,545	393,252
San Juan	1,866	0	3,100	0	0
Skagit	76,682	582	25,600	14,017	0
Snohomish	44,656	2,662	134,600	25,814	0
Thurston	18,283	1,175	49,900	3,459	0
Whatcom	55,732	0	42,800	50,999	0
Basin-wide	--	--	--	18,800	--
	326,942	21,037	1,075,800	268,187	428,266

[a] Data were summed from county-wide usage data for individual pesticides presented in Appendix C and include basin-wide railway usage. Pentachlorophenol usage is not included. Urban usage includes all urban usage data from Tables C2-C13. Values are substantially higher than those for major urban pesticides presented in Table 4.

[b] Agriculture, WDOW.

[c] WDNR, Private Timber.

[d] Cities/school districts, urban land/vegetation, miscellaneous urban, private households, and antifoulants categories. Estimated by a combination of local surveys and extrapolation from primarily out-of-state data, rounded off to the nearest hundred.

[e] County Roads, WDOT, U.S. DOT, U.S. DOE, USDI, Army Corps of Engineers, railways.

[f] Army, Air Force, Navy.

TABLE 7. ESTIMATED TOTAL PESTICIDE USAGE IN FIVE WATERSHEDS (POUNDS OF ACTIVE INGREDIENTS PER YEAR)[a]

Major Uses[b]	Snohomish	Cedar/Green	Puyallup	Nisqually/ Deschutes	Stillaguamish
Agriculture	44,962	21,014	19,111	17,333	8,931
Forestry	4,272	1,593	4,617	2,009	612
Urban[c]	114,500	527,000	194,000	50,000	2,700
Rights-of-way[d]	50,458	45,282	35,923	14,524	4,647
Military installations	0	0	235,951	157,301	0
	214,192	594,889	489,602	241,167	16,890

[a] Estimated pesticide usage for the remaining major watersheds of the basin are presented in the text (see Section 2.3.2).

[b] For identification of major use categories, see legend to Table 6.

[c] Estimated by local surveys and extrapolation from out-of-state data.

[d] These figures do not include estimated railway right-of-way usage (18,800 lb basinwide), the majority of which is applied to the Cedar/Green and Puyallup watersheds (Johnston, D., 25 May 1988, personal communication). Exact figures for county or watershed usage rates are unavailable.

individual pesticides cannot be accurately located to a particular watershed. However, county usage data can be used to rank-order pesticides in the five watersheds based on their estimated relative usage in the counties that contain these watersheds. Since urban pesticide usage in each county is based on extrapolation from a common urban pesticide usage base, no differences in relative ranking can be made among these pesticides in either counties or watersheds. An estimated ranking by usage of pesticides in the five watersheds is presented in Table 8.

2.4 ENVIRONMENTAL FATE AND TOXICITIES OF PESTICIDES

Environmental fate and toxicity data are included as criteria to evaluate the relative level of concern for pesticides used in the Puget Sound basin. Criteria for evaluating relative fate and toxicity are described, and data on these are presented for each of the pesticides estimated to be used in the basin. Pesticides and pesticide degradation products with greatest persistence and toxicity to aquatic organisms are noted.

2.4.1 Criteria for Fate and Toxicity Evaluation

The pesticides used in the Puget Sound basin represent diverse classes of chemicals, and their fate and toxicity in the environment reflect this diversity. Because of significant concern over leaching of pesticides into groundwater, much information has recently become available on the fate of pesticides in the environment, particularly those used in agriculture. Much less is known about pesticides used primarily in urban areas and households.

The potential for a particular pesticide to be transported to the aquatic environment is largely determined by its chemical and physical properties. These properties have been quantified previously by others to predict the fate of chemicals in the environment (Kenaga and Goring 1980). The values presented in this report for these properties were used to estimate potential migration and bioaccumulation for the purpose of ranking only, and are not intended to represent actual effects in the Puget Sound environment. These physical and chemical properties have been grouped into

TABLE 8. RANKING OF PESTICIDE USAGE IN FIVE WATERSHEDS

Use Category[a]	Snohomish and Stillaguamish	Cedar/Green	Puyallup	Nisqually/ Deschutes
Agriculture	2,4-D Dicamba Vernolate Parathion Atrazine Alachlor Butylate Propham Simazine Carbaryl Phorate Methyl parathion	Dicamba 2,4-D Vernolate Parathion Simazine Carbaryl Atrazine Alachlor	Dicamba 2,4-D Simazine Disulfoton Diphenamid	2,4-D Dicamba Bromacil Simazine Vernolate Disulfoton Atrazine Diphenamid Boric Acid Alachlor
Forestry	2,4-D Triclopyr Glyphosate Fosamine ammonium Dicamba	Triclopyr Fosamine ammonium 2,4-D Glyphosate	Triclopyr Glyphosate	Triclopyr 2,4-D Glyphosate
Right-of-Ways	Prometon Atrazine Simazine Tebuthiuron Glyphosate 2,4-D Triclopyr Dicamba Diuron	Prometon Atrazine Simazine Tebuthiuron 2,4-D Diuron Dicamba	Prometon Tebuthiuron Simazine Atrazine 2,4-D Triclopyr Diuron Fenvalerate	Atrazine Diuron Prometon Tebuthiuron Glyphosate Atrazine Triclopyr 2,4-D
Military installations	--	--	2,4-D Malathion Triclopyr Bromacil Sodium metaborate	2,4-D Malathion Triclopyr Bromacil Sodium metaborate

TABLE 8. (Continued)

Urban - All Watersheds
Methyl Bromide
Sulfuryl Fluoride
Diazinon
Malathion
Metaldehyde
Chlordane
Chlorpyrifos
Endosulfan
Ziram
Acephate
Glyphosate
Triclopyr
Azinphos-methyl
Dichlobenil

[a] For identification of use categories, see legend to Table 6.

three major characteristics that are then used to identify the potential environmental fate of each pesticide. Although field-derived degradation coefficients would be more applicable for assessing pesticide persistence in the soil, they are not generally available. These major characteristics are briefly defined as:

- Persistence - the potential for a pesticide to resist chemical, physical, and biological degradation
- Mobility - the potential for a pesticide to migrate from the source of application into aquatic environments, including riverine and marine environments
- Bioaccumulation potential - the potential for a pesticide to concentrate in biological tissue, which may indicate a potential to move up the food chain.

Potential persistence and mobility of chemicals in the environment are also determined by environmental factors such as soil characteristics at the site of application. These characteristics include cation exchange capacity, grain size distribution, pH, organic content, moisture content, and other soil properties (Wauchope and Leonard 1980; Khan 1980). For example, 2,4-D free acid forms hydrogen bonds with both silica and organic matter in soil. Although it is highly water soluble, its potential to leach from soils is dependent on the availability of bonding sites on soil constituents. To adequately predict potential migration of a particular pesticide from a site of application, physical and chemical properties of the soils would have to be well-characterized at that site. In a limited analysis of a geographically diverse environment such as the Puget Sound basin, specific soil characteristics at each site of application cannot be adequately described.

The remainder of this section presents a very general description of the criteria used to evaluate each pesticide. The applicability of each criteria to each pesticide is only assumed, and is not discussed at length.

Pesticide persistence can be estimated from the following quantifiable characteristics (Spencer and Cliath 1975; Khan 1980; Kenaga and Goring 1980).

- Soil residence time (soil T) - Total time of detection in soil. Experimentally derived values were used for this variable, except when only field values were available. This characteristic includes microbial and chemical degradation, and is affected by properties of the soil described above. Consequently, these values may be highly variable.

- Soil half-life (soil t 1/2) - Time required for one-half the measured quantity of pesticide in soil to disappear. Experimentally derived values were used, and may be highly variable for reasons described above.

- Hydrolysis half-life (hydrolysis t 1/2) - Time required for one-half the measured quantity of pesticide in water to disappear because of reaction with the water.

- Photolysis half-life (photolysis t 1/2) - Time required for one-half the measured quantity of pesticide to disappear because of breakdown by exposure to light.

- Vapor Pressure (mm Hg) - A relative measure of potential volatility from the soil, which can be expressed as a function of vapor pressure, aqueous solubility, and soil adsorption (Lyman et al. 1982). Volatility from water also depends on gas- and liquid-phase exchange coefficients. High vapor pressure may indicate high dispersion potential. It is not reliable as a measure of persistence for pesticides injected into the soil, and may be inaccurate when pesticides are present in water.

Potential mobility of a pesticide can be estimated from the following characteristics (U.S. EPA 1986a):

- Soil adsorption (K_{OC}) - Propensity of a pesticide to adhere to soil particles. Soil adsorption is largely dependent on the hydrophobicity of the compound and type of soil, and in general is a function of the content of organic material in soil. K_{OC} is the concentration of a chemical sorbed by the soil, expressed on a soil organic carbon basis, divided by the concentration of chemical in the soil water. Numerous other measures of soil adsorption exist, but are less frequently reported (Hague 1975).

- Water solubility (ppm) - The propensity for a pesticide to dissolve in water. Water solubility is the most frequently reported and useful measure of the potential for a pesticide to migrate to aquatic environments.

Potential bioaccumulation can be estimated from the following characteristics (Kenaga and Goring 1980):

- Bioconcentration factor (BCF) - The ratio of concentration of pesticide in biological tissue to that in surrounding aqueous environment. BCF is a major variable for estimating the potential of a chemical to accumulate in organisms, and is generally calculated from K_{OW} values or water solubility (Kenaga and Goring 1980; Lyman et al. 1982). Since BCFs are frequently not available in the data sources, log K_{OW} values are presented as a secondary measure of bioaccumulation potential. Where BCF and log K_{OW} values are not in agreement with respect to their relation to threshold values, BCFs are given greater weight.

- Octanol/water partition coefficient (log K_{OW}) - An empirical measure of the solubility of a pesticide in fat vs. its solubility in water (the ratio of concentration in 1-octanol to that in water). The log of the K_{OW} ratio is used in numerous mathematical formulas to estimate the bioconcentration factors.

Acute toxicity data (96-h exposures except where indicated) are provided for freshwater and marine fishes. The two freshwater species are bluegill *(Lepomis macrochirus)* and rainbow trout *(Salmo gairdneri)*. The two marine species are brown shrimp *(Penaeus aztecus)* and killifish *(Oryzeas latipes)*. Acute toxicity data are also supplied for mallard duck *(Anas platyrhynchos)* and the laboratory rat *(Ratus ratus)*. Toxicity data on bivalves and other marine and freshwater species were not used in the evaluations because of insufficient data.

TBT toxicity data were abstracted from studies in which free concentrations of TBT were measured in the aqueous medium (U.S. EPA 1985a). This precaution is necessary to avoid inaccuracies in the reported concentrations of TBT due to adherence of the compound to experimental apparatus (M & T Chemical Co. 1976, 1977, 1978).

Chronic toxicity data are presented as oncogenicity (O), mutagenicity (M), and teratogenicity (T). The numbers 2, 1, and 0 are used to represent demonstrated effect (2), potential or suspected effect (1), and demonstrated absence of effect (0), respectively.

2.4.2 Pesticide Fate and Toxicity Data

Values for nine environmental fate variables are provided in Table 9 and for the toxicity criteria in Table 10 for each pesticide estimated to be used in the Puget Sound basin. The chemical classification of each pesticide may be found in Table 2. These data are from the most readily available sources, listed in Table A1 (Appendix A) under the headings "Pesticide Databases", "Pesticide Compendia", and "Pesticide Reviews". Material Safety Data Sheets and pesticide labels filed with U.S. EPA as part of the registration process were generally insufficient sources of data on these variables. Where values for a specified variable were different in the databases, compendia, and reviews, priority was given to the following sources:

- First, U.S EPA-originated databases (AQUIRE and OHM/TADS)

TABLE 9. ENVIRONMENTAL FATE DATA

		PERSISTENCE				MOBILITY			BIOACCUMULATION POTENTIAL	
CLASSIFICATION	PESTICIDE	SOIL T (days)	SOIL t1/2 (days)	HYDROLYSIS t1/2 (days)	PHOTOLYSIS t1/2 (days)	VAPOR PRESSURE (mmHg)	SOIL ADSORPTION (Koc)	WATER SOLUBILITY (ppm)	LOG OCTANOL WATER PARTITION COEFFICIENT (LOG K_{ow})	BIOCONCENTRATION FACTOR (BCF)
Anilides	Alachlor	90-360			stable	2.20E-05	190	245.0	2.92	0
	Metolachlor					1.30E-05		530.0		
Anilines	Benfluralin	< 30			low		10700	< 1.0		
	Propham (IPC)	28	2-50		> 14		51	245.0	1.71	
Benzimidazoles	Benomyl	112-280	90-365					2.0	2.53	
	Oxycarboxin							1000.0		
Benzoic Acids	Chloramben		14	stable	< 2	7.00E-03	low	700.0	2.32	
	DCPA		21	> 7	stable			5-5000.0	4.15	
	Dicamba	365	15-150	stable		3.75E-03	2	6500.0	3.67	0
Bipyridiliums	Paraquat		500-4745	> 30		1.00E-07	15473	1000000.0	-8.29	
	Diquat	365		2-3				700000.0		
Botanicals	Rotenone				unstable			15.0		
Carbamates	Aldicarb		14	70-4550		5.00E-02	36	6000.0		42
	Bendiocarb		4	10		5.00E-06		40.0		200-400
	Carbofuran		200	100-350		2.00E-05	120	700.0	2.26	0
	Ferbam			unstable				130.0		
	Propoxur					1.00E-01		2000.0	0.14	146
	Carbaryl	21	7-10	7	7	5.00E-05	390	120.0	0.14	< 1
	Methomyl		40			5.00E-05	160	10000.0	-3.56	
Carboxylic Acids	Chlorflurenol							18.0		
Chlorinated Cyclodienes	Aldrin		> 1095			2.30E-05	410	< 0.1		3140
	Chlordane		> 1095	> 200		1.00E-05		< 0.1	3.30	8260-11400
	Dieldrin		> 1095					< 0.1	3.70	4420-5800
	Endosulfan sulfate	280		178	7			0.1	3.66	
	Endosulfan - alpha	119	60	30		1.00E-05	44500	0.5	3.55	
	Endosulfan - beta	119	> 730	30			44500	0.3	3.62	600
	Endrin		> 365					< 0.1	5.34	1360-4050
	Heptachlor		400					< 0.1	3.80	2150-17400
Coumarins	Warfarin							insoluble		
Dicarboximides	Captan		4	0.5		6.00E-05	224	3.3	2.35	0
	Captafol							1.4		
	Octyl bicycloheptene-carboximide							insoluble		
Halogenated Hydrocarbons	Dalapon	30-90	15	30			low	502000.0	3.87	3
	Dichloropropene		3-37	unstable		2.70E+01		1000.0	25.00	
	Dicofol (Kelthane)			168	stable			1.2	5.56	
	Lindane		151-266				911	0.2	2.80	325-560
	Methyl Bromide	< 30	< 14	20		1.25E+03		13000.0	-1.19	
Heterocyclic Nitrogens	Maleic Hydrazide	< 30	14-100	stable		0.00E+00		6000.0	-3.67	

TABLE 9. (Continued)

		PERSISTENCE				MOBILITY			BIOACCUMULATION POTENTIAL	
CLASSIFICATION	PESTICIDE	SOIL T (days)	SOIL t1/2 (days)	HYDROLYSIS t1/2 (days)	PHOTOLYSIS t1/2 (days)	VAPOR PRESSURE (mmHg)	SOIL ADSORPTION (Koc)	WATER SOLUBILITY (ppm)	LOG OCTANOL WATER PARTITION COEFFICIENT (LOG K_{ow})	BIOCONCENTRATION FACTOR (BCF)
Heterocyclic Nitrogens	Oxadiazon		90-180					0.7		
Inorganics	Aluminum Phosphide							insoluble		
	Ammonium Sulfamate	< 30						2160000.0		
	Boric Acid				7			20000.0		
	Cuprous Oxide							insoluble		
	Lime Sulfur							soluble		
	Sodium Chlorate	150						790000.0		
	Sodium Metaborate	700						13000.0		
	Sulfur							insoluble		
	Sulfuryl Fluoride							50000.0		
Inorganic-organics	Copper Naphthenate							insoluble		
	TriButylTin									9167
Miscellaneous Organics	Acrolein	< 30								
	Chloropicrin		< 14			1.69E+01		2270.0	2.32-2.42	
	Dioxathion							insoluble		
	Mefluidide							180.0	1.98	
	Metaldehyde							200.0		
	Oxyfluorfen							0.1		
	Piperonyl Butoxide			stable	stable					
	Pronamide	60-270	10-120	> 40		8.50E-05	200	15.0	3.18	
Nitriles	Bromoxynil	< 30						130.0		
	Chlorothalonil		1-30	28-72	> 168	1.00E-02	26	0.6	1.32	
	Dichlobenil	730	30			5.50E-04	235	18.0		55
Nitroanilines	Trifluralin		45-100			1.10E-04	13700	0.6	5.34	926-4570
Organic Arsenicals	Cacodylic Acid	< 30		high			high	660000.0		low
	DSMA	< 30						280000.0		
	MSMA	< 30		stable	stable	low		1400000.0	-3.10	20-1600
Organophosphates	Acephate		6-13	50		1.70E-06		650000.0		0
	Azinphos-methyl			< 0.5				33.0		16
	Bensulide	120-360						25.0		
	Chlorpyrifos	112	63			1.87E-05	6100	2.0	5.11	320-450
	Diazinon	84	32-48	1.5		1.40E-04		40.0	1.92	35
	Dichlorvos		< 1			3.20E-02		10000.0	1.40	
	Disulfoton		90-180	1		1.80E+00	1603	25.0	1.93	
	Fenamiphos	120-180		4.8		7.50E-07		700.0		
	Fenthion		45-180					2.0		
	Fosamine Ammonium		10	stable			high	1790000.0		
	Glyphosate		40	70			2600	10000	-3.2	
	Malathion	7	< 1	< 1	41	4.00E-05	1797	145.0	2.36	0

TABLE 9. (Continued)

CLASSIFICATION	PESTICIDE	PERSISTENCE				MOBILITY			BIOACCUMULATION POTENTIAL	
		SOIL T (days)	SOIL t1/2 (days)	HYDROLYSIS t1/2 (days)	PHOTOLYSIS t1/2 (days)	VAPOR PRESSURE (mmHg)	SOIL ADSORPTION (Koc)	WATER SOLUBILITY (ppm)	LOG OCTANOL WATER PARTITION COEFFICIENT (LOG K_{ow})	BIOCONCENTRATION FACTOR (BCF)
Organophosphates	Methamidophos	7-21				3.00E-04		2000000.0		
	Methyl Parathion		15	3	unstable		9800	57.0	3.11	95
	Mevinphos		35-120					soluble		
	Monocrotophos							1000000.0	-0.6	
	Naled					2.00E-04		500.0		
	Oxydemeton-methyl			0.3				330.0		
	Parathion	90	18	18		5.70E-06	4800	20.0	3.81	335
	Phorate		20-100	3		8.40E-04	3225	50.0	1.93	
	Propetamphos			365	stable			110.0		
	Temephos			stable				insoluble		
Phenols	Dinoseb	< 30		> 30	0.6	1	< 5	500.0	3.69	
	PCNB (Quintozene)		1000					insoluble		
	Pentachlorophenol	< 72	20-100			1.10E-04	900	80.0	5.01	16-130
Phenoxyaliphatic Acids	2,4,5-T	45-270	16		2-4	3.00E+01	53	6000.0	0.60	25
	2,4-D Acid	30-180	variable	low		4.00E-01	20	900.0	1.59-2.0	0
	2,4-D Amine Salts	< 30		unstable			109	> 750000.0		
	2,4-D Esters	< 30		unstable	slow	variable		slight		
	2,4-D Sodium	< 30						750000.0		
	MCPP	90						46.0		
Pyrethrins	Fenvalerate		high		stable			< 1.0		200
	Permethrin							0.2	2.87	73
	Phenothrin							2.0		
	Pyrethrins				unstable			1.0		
	Resmethrin				unstable			< 1.0		
Pyridines	Aminopyridine							83000.0		
Pyridine-Carboxylic Acids	Picloram		28-300	stable	unstable	6.20E-07	17	430.0	0.30	< 1
	Triclopyr		46	stable	0.5	1.26E-06	27	43000.0	0.47	0.02
Pyrimidines	Sulfometuron-methyl		28	14				10.0		
Substituted Amides	Diphenamid	90-180	45-180	stable	stable			260.0	2.29	
	Napropamide	< 30					680	73.0		
	Oryzalin	90-365					3141	0.7		
Thiocarbamates	Butylate		21-91	7-70		1.30E-03		46.0		33
	Mancozeb							insoluble	1.00	
	Maneb			unstable				insoluble		
	Metam	14		unstable				720000.0		
	Metiram							insoluble		
	Thiram		> 40					30.0		
	Vernolate	30-90	15-45					90.0		
	Ziram		low	unstable				65.0		

TABLE 9. (Continued)

		PERSISTENCE					MOBILITY		BIOACCUMULATION POTENTIAL	
CLASSIFICATION	PESTICIDE	SOIL T (days)	SOIL t1/2 (days)	HYDROLYSIS t1/2 (days)	PHOTOLYSIS t1/2 (days)	VAPOR PRESSURE (mmHg)	SOIL ADSORPTION (Koc)	WATER SOLUBILITY (ppm)	LOG OCTANOL WATER PARTITION COEFFICIENT (LOG K_{ow})	BIOCONCENTRATION FACTOR (BCF)
Triazines	Atrazine	90-360	28-399	70		3.00E-07	149	70.0	2.68	17
	Chlorsulfuron							27900.0		
	Hexazinone		175	> 56	37		low	33000.0	-4.40	1.8
	Metribuzin		35-63	28	15	1.00E-05	95	1200.0	-5.00	
	Prometon		459-1123	stable	> 14	2.30E-06	350	750.0	-1.06	
	Simazine	365	28-112	56-210	insignificant	3.60E-08	138	5.0	2.19	1
Triazoles	Amitrole	< 30	5-45	50			high	280000.0		
Uracils	Bromacil	360	140-182			8.00E-04	10	815.0	2.00	
	Diuron	180-700	328			3.10E-06	310	42.0	2.69	
	Monuron	365					100	230.0	1.50	
	Tebuthiuron		> 336	> 60	15		620	2500.0		
	Terbacil		175	> 42	> 28		51	710.0	-1.41	

All sources of information are listed in Table A1.

TABLE 10. TOXICITY DATA

		ACUTE										CHRONIC		
		FRESHWATER LC50				MARINE LC50				ANIMAL LD50		ANIMAL RESPONSE[b]		
CLASSIFICATION	PESTICIDE	BLUEGILL (ppm)	EXP. (hr)	TROUT (ppm)	EXP. (hr)	SHRIMP (ppm)	EXP. (hr)	KILLIFISH[a] (ppm)	EXP. (hr)	RAT (mg/kg)	WATERFOWL (mg/kg)	O	M	T
Anilides	Alachlor	3.2	96	1.4	96					1800				
	Metolachlor	15	96	2	96					2780		2	0	0
Anilines	Benfluralin	0.37	96							>10000	>2000			
	Propham (IPC)	32	48	4 - 14	96					5000	2000	1	1	2
Benzimidazoles	Benomyl	0.91 - 1.6	96	0.26 - 0.51	96					>10000	>500			
	Oxycarboxin	28.1	96	19.9	96					2000	4640			
Benzoic Acids	Chloramben									5620		0	1	0
	DCPA	700	96			1.0	48			>10000		0	0	0
	Dicamba	135	96	50	96	>100	96	(>180	96)	1040	>10000	0	0	0
Bipyridiliums	Paraquat	8.5 - 19	96	2 - 19	96					150		1	2	1
	Diquat	175 - 342	96	11.2	96	10	48			231				2
Botanicals	Rotenone	0.020 - 0.025	96	0.032 - 0.057	24					132 - 1500	2000	0		
Carbamates	Aldicarb		96	0.56 - 0.88	96					7	4.44	0		
	Bendiocarb	1.45	24	1.55	96					40 - 120			0	
	Carbofuran	0.19 - 0.31	96	0.27 - 0.53	96			(0.39	96)	11				
	Ferbam	3.6	96	2.0	96			0.8	48	>17000				
	Propoxur	4.8	96	8.2	96					95 - 104		1	0	0
	Carbaryl	2 - 6.76	96	1.07 - 1.5	96	0.01 - 0.04	24	1.75	24	505	2179	1	1	0
	Methomyl	0.428 - 1.05	96	0.764 - 7.5	96					17 - 24		0	0	0
Carboxylic Acids	Chlorflurenol	0.022	96	0.044	96					12500				
Chlorinated Cyclodienes	Aldrin	0.052 - 0.077	96	0.023 - 0.029	96	0.008	96	0.017	96	40 - 60				
	Chlordane	0.040 - 0.081	96	0.037 - 0.048	96	0.11	96	0.012	96	367 - 515	800	2	0	0
	Dieldrin	0.009 - 0.013	96	0.0009 - 0.008	48	0.0004 - 0.05	96	0.007	96	40 - 60		0		
	Endosulfan sulfate												0	
	Endosulfan - alpha	0.0012	96	0.0012 - 0.0016	96	0.01	48	0.001	96	70	205	2	2	0
	Endosulfan - beta									240				
	Endrin	0.0005 - 0.0007	96	0.0006 - 0.0008	96	0.7 - 2.3	96	0.3	96	7 - 15				
	Heptachlor	0.004 - 0.019	96	0.007 - 0.025	96	0.008 - 0.44	96	0.003	96	147 - 220		2	0	0
Coumarins	Warfarin			>10000	96					3 - 8.7	>120			2
Dicarboximides	Captafol	0.049 - 0.070	96	0.013 - 0.032	96			0.03	48	5000 - 6200				
	Captan	0.12 - 0.17	96	0.32	72					8400	5000	1	1	0
	Octyl bicycloheptene-carboximide									3640				
Halogenated Hydrocarbons	Dalapon	105 - 440	96	100 - 340	96	100	48	1.0	24	970	>2000	0	0	0
	Dichloropropene	0.7 - 1.1	96	0.11 - 0.32	96					250 - 500		2	2	1
	Dicofol (Kelthane)	0.042 - 0.642	96	100	48	0.5	96			684 - 1100	1700 - 1900			
	Lindane	0.060 - 0.078	96	0.001 - 0.032	96	0.005 - 0.010	96	0.028	96	88 - 125				
	Methyl Bromide	11	96							200		1	2	
Heterocyclic Nitrogens	Maleic Hydrazide	1608	96	1435	96					3900 - 6950		0	1	1
	Oxadiazon			1 - 9	96					>5000	>1000			

TABLE 10. (Continued)

		ACUTE										CHRONIC		
		FRESHWATER LC50				MARINE LC50				ANIMAL LD50		ANIMAL RESPONSE[b]		
CLASSIFICATION	PESTICIDE	BLUEGILL (ppm)	EXP. (hr)	TROUT (ppm)	EXP. (hr)	SHRIMP (ppm)	EXP. (hr)	KILLIFISH[a] (ppm)	EXP. (hr)	RAT (mg/kg)	WATERFOWL (mg/kg)	O	M	T
Inorganics	Aluminum Phosphide			1 - 10	96									
	Ammonium Sulfamate			0.6	96					3900				
	Boric Acid			1939	--					2660				
	Cuprous Oxide									470				
	Lime Sulfur	44 - 53	96	8	96									
	Sodium Chlorate			7.3	48					4950				
	Sodium Metaborate			1800	48					4500 - 6500				
	Sulfuryl Fluoride													
Inorganic-organics	Copper Naphthenate									>6				
	TriButylTin Oxide					0.008	96	(0.003	96)	>10000				
Miscellaneous Organics	Acrolein	100	96	46 - 183	24	0.100 - 0.190	96	0.28	48	46				
	Chloropicrin	0.105	96	0.017	96					250				
	Dioxathion	0.03 - 0.06	96	0.059 - 0.081	96	0.285	24	0.0005	24	45				
	Mefluidide	>100	96	>100	96					>4000	>10000			
	Metaldehyde									630				
	Oxyfluorfen	low								>5000				
	Piperonyl Butoxide	0.004 - 0.005	96	0.003 - 0.004	96					>7500				
	Pronamide									8350		1	1	
Nitriles	Bromoxynil			0.15	48					260				
	Chlorothalonil									>10000		2	0	1
	Dichlobenil	14.7 - 20	48	20	48					500 - 2700	>10000			
Nitroanilines	Trifluralin	0.047 - 0.070	96	0.026 - 0.062	96	0.25 - 1.2	48			>10000		2	0	0
Organic Arsenicals	Cacodylic Acid									1350	>2000	0	1	1
	DSMA	>1000	48							1800				
	MSMA	12 - 95.8	96	100	96	>1.0	96			700 - 900				
Organophosphates	Acephate	>1000	96	100 - 1100	96	3.8 - 10	96	85	96	700	350	1	1	0
	Azinphos-methyl	0.022	96	0.0032 - 0.02	96	0.00003	48			17.5	136			0
	Bensulide	0.8	96	0.7	96					339 - 770				
	Chlorpyrifos	0.004	24	0.003	96	0.0028	24	0.0006	96	145				
	Diazinon	0.022	96	0.38	24	20	24	(1.47	96)	300 - 400	3.54	0	0	0
	Dichlorvos	1.0	24	0.187	96	0.004	96	2.4	24	56 - 108				
	Disulfoton	0.3	96	1.85	96	50 - 58	48	(0.74	24)	2 - 12		0	2	0
	Fenamiphos			0.11	96					8.1 - 9.6				
	Fenthion	1.1 - 1.7	96	1.3 - 2.0	96			0.45	96	255 - 298				
	Fosamine Ammonium	670	96	>1000	96					24000	>10000			
	Glyphosate	4.2 - 7.5	96	7.0 - 156	96					4300 - 4900	>4600	0	0	0
	Malathion	0.087 - 0.122	96	0.087 - 0.310	96	0.33 - 1.0	48	0.014	96	1000 - 1375		0	1	1
	Methamidophos			51	96					18 - 21				
	Methyl Parathion	2.0 - 5.7	96	2.75 - 5.3	96	0.001	24	0.79	96	14		0	2	2
	Mevinphos	0.020 - 0.026	96	0.011 - 0.013	96	0.013	24	0.075	24	2.2 - 4.15				

TABLE 10. (Continued)

		ACUTE										CHRONIC		
		FRESHWATER LC50				MARINE LC50				ANIMAL LD50		ANIMAL RESPONSE[b]		
CLASSIFICATION	PESTICIDE	BLUEGILL (ppm)	EXP. (hr)	TROUT (ppm)	EXP. (hr)	SHRIMP (ppm)	EXP. (hr)	KILLIFISH[a] (ppm)	EXP. (hr)	RAT (mg/kg)	WATERFOWL (mg/kg)	O	M	T
Organophosphates	Monocrotophos	23	96	12	96					8 - 23				
	Naled	2.2	96	0.053 - 0.302	96			0.5	96	430				
	Oxydemeton-methyl	10	96	10	96					47 - 180	53.9			
	Parathion	0.1 - 0.71	96	2.0	24	0.43	24	0.02	48	4 - 13	2.34	1	2	2
	Phorate	0.005	48	0.011 - 0.016	96			0.0004	48	1.6 - 3.7	0.6 - 2.55		0	1
	Propetamphos									119				
	Temephos	0.8 - 30.5	96	0.1 - 6.77	96			1	96	8600				
Phenols	Dinoseb	105	96	179	48	5.1	96	2.3	96	4700	>5000	0	0	2
	PCNB (Quintozene)	0.29	96	0.31	96					12000		1	2	2
	Pentachlorophenol	0.023 - 0.044	96	0.05	96	3.3	66	(0.329	96)	50 - 140		0	2	1
Phenoxyaliphatic Acids	2,4,5-T	42 - 47	96	0.53 - 0.77	96					300 - 1700	>4650	1	1	2
	2,4-D Acid	1.5 - 2.5	24	1.5 - 2.2	48	2.0	96	5.0	48	375	1000	0	2	2
	2,4-D Amine Salts	188 - 416	24	250	24									
	2,4-D Esters	0.6 - 1.3	96	0.8 - 1.1	96	2.0	96	5.0	48	350 - 700	2025	0	2	2
	2,4-D Sodium	168	96	>100	96					660 - 805				
	MCPP			115	96					930				
Pyrethrins	Fenvalerate			0.036	96					>3200	5.90			
	Permethrin			0.001 - 0.008	96					4000				
	Phenothrin	0.018	96	0.017	96					>10000				
	Pyrethrins	0.4	96	0.030 - 0.057	96					584 - 900				
	Resmethrin	0.0003 - 0.0009	96	0.001 - 0.003	96					4240				
Pyridines	Aminopyridine	2.8 - 11.8	96	<10	96	3.3	24			20	<10	1		2
Pyridine-Carboxylic Acids	Picloram	18 - 30	96	0.8 - 16.5	96	>1.0	96			8200		0	1	1
	Triclopyr	148	96	117	96	895	96			630	>10000			
Pyrimidines	Sulfometuron-methyl									>5000				
Substituted Amides	Diphenamid					58	48			1000		0	0	0
	Napropamide							0.13	24	500 - >5000				
	Oryzalin									>10000	>500			
Thiocarbamates	Butylate									3500 - 5431		0	0	0
	Mancozeb									11200		2	2	2
	Maneb					3.5 - 10	48			7990	>10000			
	Metam									1700 - 1800				
	Metiram									10000				
	Thiram	0.23	96	0.13	96					780				
	Vernolate	1.7 - 3.7	96	3.9 - 4.7	96	0.24 - 1.9	48			1200 - 1470				
	Ziram									1400				
Triazines	Atrazine	116	96	4.5 - 8.8	96	10 - 33	48			1780		2	2	0
	Chlorsulfuron	>250	96	>250	96					5545	>5000	0	0	0
	Hexazinone	370 - 420	96	320 - 420	96	<100	96			1690	10000	0	0	0
	Metribuzin	80	96	76	96					1100 - 2300		0	0	0
	Prometon	40	96	12	96					2980				0

TABLE 10. (Continued)

		ACUTE										CHRONIC		
		FRESHWATER LC50				MARINE LC50				ANIMAL LD50		ANIMAL RESPONSE[b]		
CLASSIFICATION	PESTICIDE	BLUEGILL (ppm)	EXP. (hr)	TROUT (ppm)	EXP. (hr)	SHRIMP (ppm)	EXP. (hr)	KILLIFISH[a] (ppm)	EXP. (hr)	RAT (mg/kg)	WATERFOWL (mg/kg)	O	M	T
Triazines	Simazine	>100	48	5 - 60	48	>100	48			>5000	>5000	1	1	0
Triazoles	Amitrole			70	96	1000 - 3300	48			25000		2		
Uracils	Bromacil	71	48	75	48					5200	10000	1	0	0
	Diuron	7.4 - 9.1	96	2.4 - 23	96	0.038 - 0.285	96	0.015	96	3400	>5000	0	0	2
	Monuron	47	96	100 - 180	24					3600		1	1	0
	Tebuthiuran	112	96	144	96					664	500	0	0	2
	Terbacil									5000 - 7000		0	0	1

All sources of information are listed in Table A1.

[a] Values in parentheses are for unknown species of marine fish.

[b] O=Oncogenicity, M=Mutagenicity, T=Teratogenicity
2=positive, 1=potential, 0=negative

- Second, the US. EPA (1987a) compendium and review (Ghassemi et al. 1981).

- Third, the remaining compendia

- Finally, the remaining reviews.

U.S. EPA databases in general do not specify source of data derivation (U.S. EPA 1986b). Consequently, quality of the original data from these sources has not been assessed and is not reflected in the ranking above.

Pesticides are listed in Tables 9 and 10 by chemical classification to facilitate comparison of data between related compounds. For some pesticides, selected data are not available. The reader is cautioned not to fill in data blanks by extrapolation from compounds in the same class because of the high within-classification variance in the data. As an example of this lack of behavioral similarity between chemicals of the same class, the persistence of triazines in the soil can range from 63 to more than 1,000 days. These constraints in comparing pesticide persistence have been described for other pesticide classes as well (Khan 1980).

Data compiled in Table 9 indicate that the most persistent pesticides include those of both high and low usage in the basin (see Tables 3 and 4). In descending order of persistence, these are the chlorinated cyclodienes (aldrin and chlordane), paraquat, PCNB, dichlobenil, sodium metaborate, benomyl, the uracils (bromacil and diuron), the triazines (prometon, simazine, and atrazine), oryzalin, bensulide, dicamba, diquat, and alachlor. Of these pesticides, prometon, simazine, dicamba, bromacil, atrazine, and diuron are among the 20 pesticides of highest use in the basin (see Table 3).

Based on freshwater fish toxicity data presented in Table 10, the most toxic pesticides among the 20 pesticides of highest use in the basin (see Tables 3 and 4) are, in descending order of toxicity, chlordane (a chlorinated cyclodiene, one of the more persistent pesticides in the environment), the organophosphates (diazinon, chlorpyrifos, glyphosate, and malathion), pentachlorophenol, and 2,4-D acid. However, a number of these compounds, particularly the organophosphates, have low persistence in the aquatic environment because of rapid hydrolysis (see Table 9).

2.4.3 Persistence and Toxicities of Pesticide Degradation Products

Although the degradation process generally renders compounds less toxic and persistent, the degradation products of many pesticides are at least as persistent as the parent compound, and may show greater toxicity. Degradation products for many pesticides used in the basin are listed in Table 11. Very little is known about actual fate and toxicity of these byproducts that would allow an evaluation of their concern as potential contaminants of the sound. Where fate and toxicity information appear to be adequate, these byproducts are included in the evaluation of the pesticides of concern in Puget Sound in the following section.

2.5 DETERMINATION OF LEVEL OF CONCERN

A major objective of this report is to present a ranking of the pesticides used in the Puget Sound basin by relative "level of concern" for potential contamination and harmful effects to the aquatic environment. The alternative levels of concern are primary, secondary, low, and uncertain. The scoring system used to rank the pesticides is based on usage (Section 2.3) and on the measurements of fate and toxicity described in Section 2.4. The scoring criteria, arranged by tier, are shown in Table 12. Tier I criteria are usage, fate, and toxicity. Tier II criteria for fate are persistence, mobility, and bioaccumulation potential. Tier II criteria for toxicity are acute freshwater toxicity, acute marine toxicity, and chronic toxicity. The acute marine toxicity threshold value was set for shrimp data only. Killifish toxicity values were not included in the evaluation because of data inadequacies. Waterfowl toxicity data were included in the evaluation for those pesticides with $LC_{50} < 10$ mg/kg. There are no Tier II criteria for usage. Tier III criteria comprise the 14 variables by which Tier II criteria are measured.

TABLE 11. DEGRADATION PRODUCTS OF PESTICIDES OF CONCERN

Pesticide[a]	Products	Relative Toxicity/Persistence	Reference
Methyl bromide	Bromide ion	Much less persistent in soil; leaches	Sassman et al. 1986
Malathion	Diethyl fumarate	Greater toxicity to fathead minnow	Murty 1986
Simazine	2-Chloro-4-ethylamino-6-amino-s-triazine 2-Chloro-4,6-bis(amino)-s-triazine	Unknown	OHM/TADS; U.S. EPA 1986b
Triclopyr	3,5,6-Trichloro-2-pyridinol	Soil t 1/2 = 90 days; low to intermediate mobility	OHM/TADS; U.S. EPA 1986b
Carbaryl	1-Naphthol	Nontoxic to terrestrial organisms; greater toxicity to molluscs; 2 times as toxic to riverine fish	OHM/TADS; U.S. EPA 1986b
Glyphosate	Aminomethylphosphonic acid (AMPA)	Unknown	OHM/TADS; U.S. EPA 1986b
Diuron	3-(3,4-Dichlorophenyl)-1-methylurea (DCPMU) 3-(3,4-dichlorophenyl) urea (DCPU)	Less mobile	OHM/TADS; U.S. EPA 1986b
Diazinon	2-Isopropyl-4-methyl-6-hydroxypyrmidine (IMHP)	Unknown	OHM/TADS; U.S. EPA 1986b
Phorate	Oxidized to sulfoxide	Greater persistence; 2 times as toxic	OHM/TADS; U.S. EPA 1986b
Disulfoton	Oxidized to sulfoxide	--	
	Oxidized to sulfone	Less mobile; persistence exceeds 290 days	
	Demeton-S	Animal toxicity is comparable, but may be mutagenic	OHM/TADS; U.S. EPA 1986b
Chlorothalonil	4-Hydroxy-2,5,6-trichloroisophthalonitrile (69%)	More stable	OHM/TADS; U.S. EPA 1986b
Fenamiphos	Oxidized to sulfoxide	More potent inhibitor of cholinesterase	OHM/TADS; U.S. EPA 1986b
Aldrin	Dieldrin	More persistent; more toxic	Tables 9, 10
Cacodylic acid	Arsines, methylarsines, and inorganic arsenate	Toxic; low mobility; persistent; soil t 1/2 = 6 yr	OHM/TADS; U.S. EPA 1986b
MSMA/DMSA	Inorganic arsenate	Toxic; low mobility; persistent; soil t 1/2 = 6 yr	OHM/TADS; U.S. EPA 1986b
Aldicarb	Oxidized to sulfoxide and sulfone	76 times as potent as a cholinesterase inhibitor. Stability in soil and water unknown	OHM/TADS; U.S. EPA 1986b
Endosulfan	Endosulfan sulfate	Greater persistence in soils; lower water solubility; greater toxicity	OHM/TADS; U.S. EPA 1986b
Captan	4-Cyclohexene-1,2-dicarboximide	Embryotoxic; possibly teratogenic.	OHM/TADS and RTECS; U.S. EPA 1986b

[a] Pesticides are listed in general order of usage in the Puget Sound basin.

TABLE 12. CRITERIA FOR RANKING PESTICIDES OF CONCERN

Tier I Criteria	Tier II Criteria	Tier III Criteria
Usage	-	-
Environmental fate	Persistence	Soil residence Soil half-Life Hydrolysis Photolysis Vapor pressure
	Mobility	Soil adsorption Water solubility
	Bioaccumulation Potential	Log K_{ow} Bioconcentration factor
Toxicity	Freshwater	Bluegill/trout
	Marine	Shrimp
	Chronic	Oncogenicity Mutagenicity Teratogenicity

Scoring involves the following steps:

1. Identify threshold values for the 15 basic criteria (i.e., the 14 in Tier III plus usage). The range of values and threshold value for each variable are listed in Table 13. Threshold values for fate and acute toxicity approximate those identified by U.S. EPA (1986a).

2. For each pesticide, assign a "high" or "low" rating to each basic criterion, based on comparison with the threshold. Usage criterion has an additional rating of "very low" for those pesticides with usage less than 1,000 lb/yr.

3. For each pesticide, assign a "high" or "low" rating to each Tier II criterion, based on the number of "high" ratings in the corresponding Tier III criteria, and the following guidance:

   Persistence - "High" if two Tier III values are available and one has a high rating, OR if there are three values available and two have high ratings, OR if at least three variables have high ratings.

   Mobility - "High" if the Tier III BCF value has a high rating, or if a BCF value is not available, the log K_{OW} value has a high rating.

   Bioaccumulation Potential - "High" if the Tier III BCF value has a high rating, or if a BCF value is not available, the log K_{OW} value has a high rating.

   Freshwater Toxicity (acute) - "High" if the one corresponding Tier III value has a high rating.

   Marine Toxicity (acute) - "High" if the one corresponding Tier III value has a high rating.

TABLE 13. THRESHOLD VALUES FOR DETERMINING LEVEL OF CONCERN FOR PESTICIDES IN THE PUGET SOUND BASIN

Usage[a]		Environmental Fate			Toxicity		
Range	Threshold	Variable	Range	Threshold	Variable	Range	Threshold
19-311,000	>4,000						
		Persistence[b]			Acute (ppm)		
		Soil T (days)	7-700	>150	Freshwater	0.005-1,800	<10
		Soil t 1/2 (days)	2-4,800	>45	Marine (shrimp)	0.00003-895	<5
		Hydrolysis (days)	2-4,550	>50			
		Photolysis (days)	2-stable	>30	Chronic		
		Vapor pressure (mmHg)	10^{-8}-10^{3}	$>10^{-1}$	Sum of Values	0-6	>1
		Mobility[c]					
		Soil adsorption (K_{OC})	2-44,500	<200			
		Water solubility	0.1-2,160,000	>200			
		Bioaccumulation potential[c]					
		Log K_{OW}	-8.0-25.0	>2.5			
		BCF	0-17,000	>100			

[a] Units are lb of active ingredients per year.

[b] Any one of two values, two of three values, or three values exceeded is assigned "High."

[c] Any one value exceeded is assigned "High."

Chronic Toxicity - "High" if the sum of values in the corresponding Tier III criteria equals 2 or more.

4. Rate Tier I criteria (except usage), using results of Step 3, and the following guidelines:

   Fate - "High" if two or more corresponding Tier II criteria have high ratings.

   Toxicity - "High" if one of two available criteria has a high rating, OR if two of three available criteria have high ratings, OR if waterfowl were found to be particularly sensitive.

5. Classify each pesticide as "primary," "secondary," "low," or "uncertain," using results of Steps 2-4 and the following guidelines:

   Primary - High Tier I ratings in usage, fate, and toxicity.

   High Tier I rating in usage plus high Tier II rating in persistence plus low Tier III rating for soil adsorption ($K_{oc} > 200$). (These pesticides are listed separately for their potential to adhere to soils and translocate to sediments or suspended particulates in riverine and marine environments.)

   High tier I rating in usage and degradation products with high persistence or toxicity (Table 11).

   Secondary - High Tier I rating in usage plus low Tier I ratings in fate and/or toxicity.

	Low Tier I rating in usage plus high Tier I rating in either fate or toxicity.
Low -	Very low Tier I rating in usage (usage <1,500 lb/yr).
	Low Tier I rating in usage plus low Tier I ratings in both fate and toxicity.
Uncertain -	Significant lack of data in either Tier II persistence or mobility.
	Significant lack of data in all three Tier II toxicity criteria.

6. Within each of the four levels of concern, rank pesticides in order of usage, starting with highest usage.

The algorithm computations (scorings of "high" or "low") for each criterion used to determine pesticide ranking in the level of concern matrix are presented in Appendix E, with adjustments to scoring described in the legend to Table E1. The final ranking of pesticides by the level of concern in Puget Sound is presented in Table 14. Pesticides are ranked by primary, secondary, low, or uncertain level of concern, and are grouped into three media most likely subject to contamination: marine and riverine waters, sediments/organic particulates, and biological tissue.

Individual pesticides of interest are discussed in the following sections. The following observations are noted:

- Nineteen pesticides are listed for primary concern: 9 in waters of the basin, 15 in sediments or suspended particulates, and 8 in biological tissue, with substantial overlap among the three groups.

TABLE 14. PESTICIDES OF CONCERN IN PUGET SOUND[a]

Level of Concern	Marine and Riverine Waters[b]	Sediments/ Organic Particulates[c]	Biological Tissue[d]
Primary[e]	2,4-D[f] Dicamba[f] Alachlor Tributyltin[f] Bromacil[g] Atrazine Triclopyr[g,h] Carbaryl[i] Diazinon	2,4-D[f] Dicamba[f] Pentachlorophenol Prometon[g] Simazine[g] Tebuthiuron[g] Chlorpyrifos Tributyltin[f] Atrazine Diuron[h] Trifluralin Phorate[h] Pronamide[g] Fenvalerate Diazinon	Tributyltin Trifluralin Chlorpyrifos Pentachlorophenol Fenvalerate Pronamide[k] Diuron[k] Dicamba[k]
Secondary[l]	Malathion[i] Dinoseb Amitrole Methamidophos Dichloropropene Acephate Diquat Propham Methomyl Diphenamid Chloropicrin Hexazinone Dichlorvos Terbacil MSMA Fenamiphos[h]	Methyl bromide[j] Chlordane[j] Glyphosate Parathion Disulfoton[i] Vernolate Methyl parathion Butylate[g] Dichlobenil Endosulfan[h] Benfluralin Azinphos-methyl Benomyl Lindane Bendiocarb	Parathion Lindane Dichloropropene[k] Dinoseb[k] Chlordane[j]
Uncertain	Sulfuryl fluoride[j] Metaldehyde[j] Sodium metaborate Propoxur[d] MCPP Metolachlor Boric acid		

TABLE 14. (Continued)

	Acrolein
	Chlorothalonil
	Oryzalin
	Propetamphos
	Pyrethrins
	Sulfmeturon-methyl
	Ziram
	Temephos
Low	Remaining pesticides listed in Tables 3 and 4.

[a] Pesticides are listed in approximate order of concern.

[b] Moderate to high mobility.

[c] Moderate to high soil adsorption, low mobility.

[d] High bioconcentration factor (BCF).

[e] High usage, persistence, and toxicity.

[f] Detected in Puget Sound (see Section 3.1).

[g] Low or uncertain toxicity.

[h] Parent compound and degradation products (see Table 11).

[i] Degradation products only.

[j] High uncertainty in usage estimate.

[k] BCF not readily available; high log K_{OW}.

[l] Low to high usage; low persistence or mobility.

- Thirty-one pesticides are listed for secondary concern in the basin.

- Sixteen pesticides were assigned an uncertain level of concern because of substantial deficiencies in environmental fate or toxicity information.

3.0 ONGOING RESEARCH, SAMPLING, AND MONITORING PROGRAMS

3.1 PESTICIDE RESEARCH IN THE PUGET SOUND AREA

The major research programs underway in the Puget Sound area that address pesticide use and effects in the sound are described in this section.

3.1.1 Agricultural Pesticides in Padilla Bay

Western Washington University (WWU) and Ecology are collaborating on a project to quantify pesticide runoff in surface waters from agricultural areas in Skagit Valley. The research group, directed by Dr. Richard Mayer of WWU's Huxley College of Environmental Sciences, is focusing on 14 pesticides presently used by the local agricultural industry around Padilla Bay (Figure 3). Pesticide usage in the area was identified by personal interviews with local agricultural representatives, including farmers and local pesticide suppliers. A list of these pesticides with their detection limits for analysis in water samples is provided in Table 15.

The research group has collected samples from the integrated water column (i.e., water from the bay that has not been filtered to remove suspended particles) and from bay sediments, and analyzed the samples for 14 pesticides. Preliminary results indicate that two of these pesticides, 2,4-D and dicamba, are detectable in water and sediments after a period of rainfall closely following the prime application period of late spring (Mayer, R., 29 February 1988, personal communication). No pesticides were detected in either media immediately prior to rainfall. This sampling schedule was designed for a worst-case scenario, with maximum probability for contaminant detection. Both pesticides are heavily used in Whatcom County (see Tables 16 and C13) and are highly water soluble (see Table 9). It is not clear why the other 12 pesticides, some of which also have high usage in that area, have not been detected.

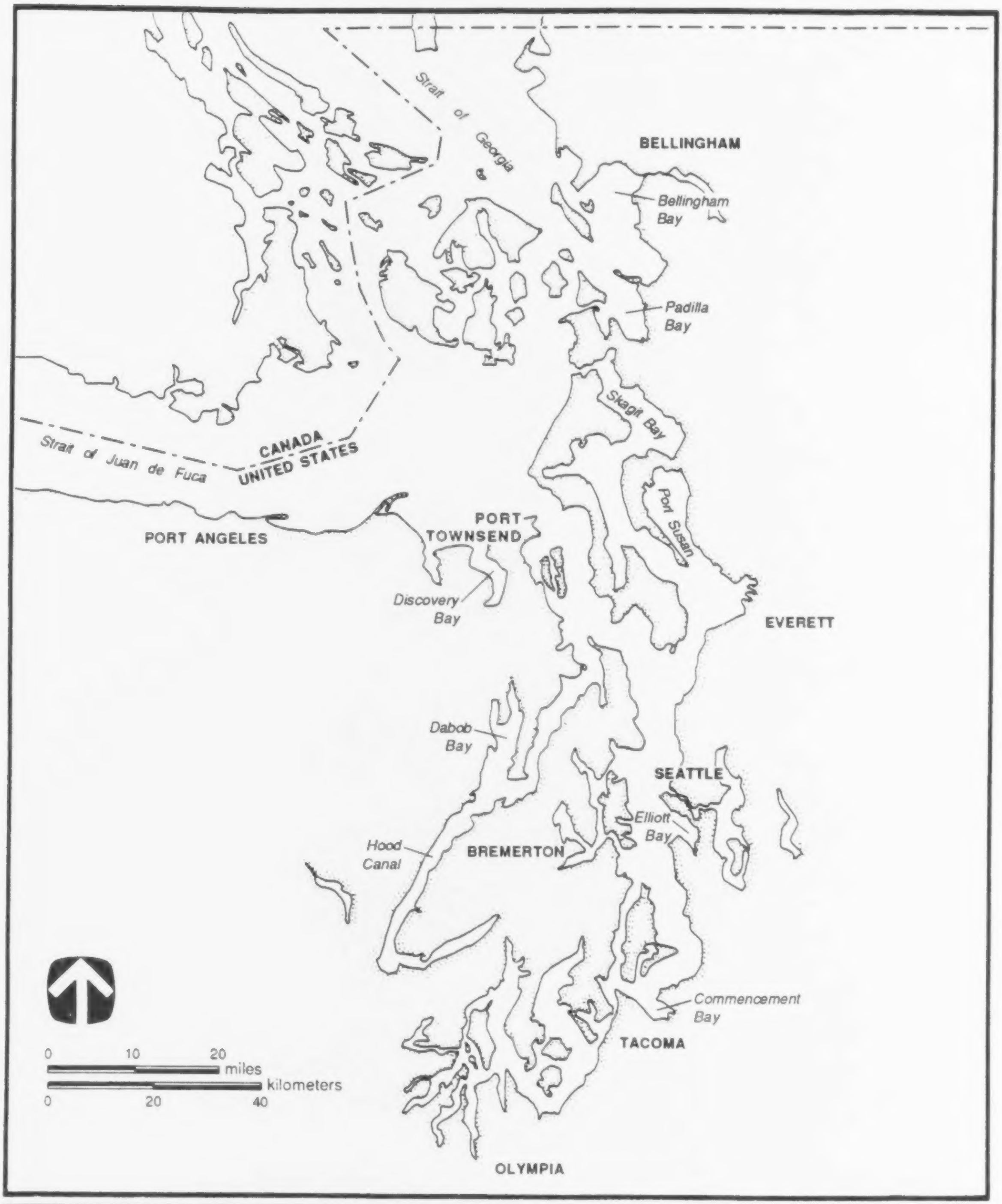
Strait of Georgia
BELLINGHAM
Bellingham Bay
Padilla Bay
Skagit Bay
CANADA
UNITED STATES
Strait of Juan de Fuca
PORT ANGELES
PORT TOWNSEND
Port Susan
Discovery Bay
EVERETT
Dabob Bay
SEATTLE
Elliott Bay
Hood Canal
BREMERTON
Commencement Bay
TACOMA
OLYMPIA
0
10
20
miles
kilometers
0
20
40

Figure 3. Location of selected bays in greater Puget Sound.

TABLE 15. PESTICIDES IN PADILLA BAY

Pesticide	Detection Limit[a] ug/L (ppb)
Trifluralin	0.019
Simazine	0.63
Atrazine	0.49
Diazinon	0.18
Chlorthalonil	0.15
Methamidophos	10.8
Methyl parathion	0.028
Parathion	0.063
Dicamba[b]	6.10
2,4-D[b]	0.048
PCNB	0.009
Dinoseb	0.113
Metribuzin	0.013
Terbutryn	5.76

[a] Water samples only. Detection limits for sediment samples were in ppm (Mayer 1987).

[b] The phenoxyacid herbicides are analyzed as the methyl esters but reported in terms of the free acid.

3.1.2 Parathion in Skagit Valley

A second study by Dr. Mayer focuses on the potential for surface water contamination following aerial application of parathion in Skagit Valley agricultural lands. The intent of this study is to actively monitor for the presence of parathion in the integrated water column and suspended solids. It is anticipated that parathion will be detected at very low concentrations because of soil adsorption and rapid hydrolysis (Mayer, R., 29 February 1988, personal communication).

3.1.3 Ethylene Dibromide in Skagit Valley

Ethylene dibromide (EDB) was a popular crop fumigant in the Skagit Valley agricultural industry until its suspension 5 yr ago. U.S. EPA concern about its potential carcinogenicity led to the suspension. A third study by Dr. Mayer monitors groundwater concentrations of EDB in Whatcom County. By calculating decay curves of EDB in soil, this study will determine its "real world soil half-life." EDB has not been detected in surface waters of Puget Sound (Mayer, R., 29 February 1988, personal communication).

3.1.4 Groundwater Contamination in Whatcom County

In response to the detection of EDB in residential wells in agricultural areas of Whatcom County, the Water Quality Investigation Section of Ecology has recently proposed to monitor residential wells in those areas for pesticide contamination. The study will focus on 21 contemporary agricultural pesticides that are used in the county. These pesticides are discussed further in Section 4.1.1.

3.1.5 Sea Surface Microlayer

Although past research has focused primarily on contaminant concentrations in the water column, sediments, and biota of Puget Sound, recent work has indicated a potential for major problems with contaminants in the surface microlayer. The microlayer is a highly productive, metabolically active interface and a vital biological habitat, and is important as a nursery ground for pelagic eggs and larvae. This thin (50 um thick), relatively stable layer of water is the entrance point for pollutants passing into the water column and an area of concentration for hydrophobic pollutants. Consequently, the microlayer can serve as an indicator of more recent pollution in the sound (Hardy, J., 1 March 1988, personal communication).

Dr. John Hardy, of the Battelle Marine Research Laboratory, recently completed a series of projects revealing the presence of pesticides, other organic compounds, and metals in the microlayer of Puget Sound (Hardy et al. in press a,b). Pesticide concentrations, primarily gamma-HCH (lindane), aldrin, and DDT, were reported at greater than 40 ug/L in the microlayers of Elliott Bay and Commencement Bay (see Figure 3). Pesticides were also present in the microlayer of central Puget Sound, indicating that contamination of the water surface is widespread. Since these pesticides are not currently reported as used in the Puget Sound basin (see Table 3), their presence in the microlayer is presumably due to transfer from other media or nonreported sources.

Research on the microlayer of Puget Sound has ceased, but similar projects continue in the Chesapeake Bay and the Southern California Bight, where significantly greater contamination of the microlayer has been observed (Hardy, J., 1 March 1988, personal communication).

3.1.6 Pesticide Effects on Wildlife

In collaboration with WWU's Huxley College, Dr. Peter Haug of WDOW is conducting a project to "... evaluate the relationship between known contamination in the Puget Sound basin and uptake of contaminants (or metabolites) and their biological impacts in wildlife" (Haug, P., 27 October 1987, personal communication). This project consists of abstracting data from the literature on chemical contamination in Puget Sound and in wildlife, and then synthesizing these data into a relational, computerized information system. Based on the data, correlative trends in contamination of the sound (including pesticides) and of indigenous wildlife will be sought.

3.2 PUGET SOUND PESTICIDE MONITORING PROGRAMS

Although many agencies monitor water, sediment, and biological resources of Puget Sound, there is no operational monitoring plan for contemporary pesticides in the Puget Sound basin (Boese, J., 30 December 1987, personal communication; Frandsen, L., 1 March 1988, personal communication; Crecelius, E., 1 March 1988, personal communication).

In a recent review by PSWQA (1986a), monitoring programs throughout the Puget Sound basin were identified. A number of programs sponsored by U.S. EPA, NOAA (the National Status and Trends Program), and Ecology monitor the sound and biota for the presence of historical pesticides, such as DDT and occasionally other chlorinated hydrocarbon pesticides (e.g., aldrin, dieldrin). These pesticides have been detected, usually at <50 ppb, in sediments of Commencement Bay, Elliott Bay, and Everett Harbor (PSWQA 1986a; Tetra Tech 1985, 1988a, 1988b), and DDT has been detected in fishes, crabs, marine birds, (glaucous-winged gull and great blue heron), and marine mammals (Gahler et al. 1982; Riley et al. 1983; Landolt et al. 1987; Norman et al. 1988; Calambokidis et al. 1988). However, neither point nor nonpoint source monitoring programs include contemporary pesticides (PSWQA 1986a). Pesticide contaminants in the sound come primarily if not solely from nonpoint sources, which include forestry and agricultural use, and urban runoff.

The need for a comprehensive monitoring program in the Puget Sound basin was emphasized by PSWQA (1986a), and suggestions and proposals have been made for the implementation of such a plan (Tetra Tech 1986; PSWQA 1987). The present plan for comprehensive monitoring of the sound (as of September 1988) is under review by PSWQA and will be included in some form in the 1989 Water Quality Management Plan to be submitted to the Washington State Legislature for funding in July 1989 (Copping, A. 17 March 1988, personal communication). In this monitoring plan, the list of organic chemicals to be monitored in sediments and fish tissue will include some pesticides in current use. Sponsoring agencies are expected to include the Washington Departments of Ecology, Wildlife, Fisheries, Natural Resources, and Social and Health Services; Metro; local governments; tribes; and federal agencies, including NOAA, U.S. EPA, U.S. Department of Interior, and the U.S. Army Corps of Engineers.

4.0 INFORMATION GAPS

As described in Sections 1.3, 2.2, and 2.4, many assumptions and uncertainties are associated with the usage and environmental effects data presented in this report. These weaknesses are summarized below.

4.1 USAGE

Usage data were compiled by a combination of methods depending on the availability of data for each use category. The quality of these data may vary considerably between these categories.

4.1.1 Agriculture

Agricultural usage data in this document are based largely on surveys by U.S. EPA (Sacha et al. 1986) and RFF (Gianessi 1986). The following uncertainties are inherent in the agricultural usage data:

- Values for the number of acres in production by crop and the percentage of each crop that is treated with each pesticide were assumed and not actually tabulated by Sacha et al. (1986). For example, corn acreage is believed to have been overestimated (Sacha et al. 1986). If these assumptions were inaccurate, then some of the usage data presented in Section 2.3 are inaccurate. It should also be noted that these values may change from year to year and county to county (Sacha et al. 1986).

- Several pesticides used for agricultural purposes in the Puget Sound watershed were identified but excluded from the database of Sacha et al. (1986) and subsequently Gianessi (1986). These pesticides are paraquat, napropramide, oryzalin, and glyphosate use on fruit trees; metribuzin and pronamide uses on hay; and EPTC use on corn. Usage data for these pesticides are not readily available.

- Two major agricultural pesticides, identified through interviews with local farmers as being used in the Skagit Valley [DCNB (Terrachlor) and terbutryn (Mayer 1987)], are not reported in Sacha et al. (1986) or Gianessi (1986) for Whatcom County. Furthermore, no user group in the 12-county watershed reported use of terbutryn. Some of the reasons for the differences between these studies are that Sacha et al. (1986) gathered data through questionnaires of county extension agents from the Cooperative Extension, whereas Mayer (1987) interviewed local pesticide sales agents, local cooperative extension agents, and farmers in the area of the field studies.

- As part of a proposal to monitor groundwater wells in Whatcom County for agricultural pesticides (see Section 3.1.4), Ecology compiled a list of pesticides sold in the county for agricultural uses (Norton, D., 13 April 1987, personal communication). Table 16 lists these pesticides and indicates those that were not included in the databases compiled by RFF (Gianessi 1986) or Sacha et al. (1986) from surveys of Whatcom County. Reasons for this discrepancy lie in the indirect survey methods used to compile the databases in contrast to Norton's reliance on pesticide sales information from interviews with local county pesticide distributors. It is apparent after comparison of Table 16 with RFF and Sacha data on Whatcom County in Table C13 (Appendix C) that these different methods of usage surveys resulted in large differences in data.

TABLE 16. PESTICIDES SOLD BY WHATCOM COUNTY AGRICULTURAL CHEMICAL DEALERS IN 1985

Pesticide	Lb of Active Ingredient
Alachlor	360
Aldicarb	210
Atrazine	13,176
Carbofuran	1,180
Dacthal[a]	48
Dicamba	2,212
Dichloropropane	5,330
Disulfoton	40
Diuron[a]	940
Fenamiphos[a]	1,560
Hexazinone	76
Methomyl[a]	392
Metolachlor	5,550
Metribuzin	400
Prometon[a]	1,930
Pronamide	453
Simazine	2,602
Terbacil[a]	25

[a] Not listed in the RFF (Gianessi 1986) or Sacha et al. (1986) databases as used by Whatcom County agriculture.

Source: Norton, D., 13 April 1987, personal communication.

4.1.2 Federal Agencies

Usage data in this category, which are based largely on a recent survey (Freimark 1985), are considered to be fairly accurate, with the following caveats:

- Certain agencies reportedly did not have precise recordkeeping systems for pesticide usage and USDA Agricultural Research Service did not cooperate fully with the investigators.

- Some of the agencies tracked actual usage (e.g., U.S. Department of Army) while others tracked proposed maximum usage (e.g., U.S. Departments of Energy and Interior).

- National park usage was reported by the U.S. Department of the Interior for 1982 only. In a few cases, pesticides were reported as used, but use was not quantified (e.g., chlorpyrifos at Olympic National Park and glyphosate and phenothrin at Mt. Rainier National Park). These data were not included in the usage tables.

- Justice Department data were not included in the usage tables. The primary pesticide user (i.e., the Drug Enforcement Agency) did not disclose use locations in Washington, although they indicated that paraquat, their major pesticide, was not used in the Puget Sound basin in 1986 and 1987 (Burne, T., 22 January 1988, personal communication).

4.1.3 U.S. Forest Service

The U.S. Forest Service is not included on the usage tabulations as a user, having been enjoined from herbicide application by the U.S. District Court in 1984. Prior to the 1984 injunction, the Forest Service used no herbicides for silviculture purposes on the Mt. Baker/Snoqualmie National Forest, and only minor amounts in the Olympic National Forest (Schafer, M., 28 June 1988, personal communication). Most silviculture herbicide applications in the Northwest Region of the U.S. Forest Service are conducted in forests of the South Cascades of Washington, the Oregon Cascades, and the forested mountain regions of southern Oregon. The forests around Puget Sound (Olympic and Mt. Baker/Snoqualmie National Forests on the west side of the North Cascades) receive considerably less herbicide treatment compared to the more southern forests because of the different precipitation patterns (shorter dry period in summer in the North Cascades forests) and different species of competing vegetation (i.e., less aggressive species in more northern forests) (Schafer, M., 28 June 1988, personal communication).

Most herbicide use in the national forests around Puget Sound prior to the injunction was for logging road right-of-ways. This resulted in herbicide treatment to about 500 ac in Olympic National Forest and 556 ac in Mt. Baker/Snoqualmie National Forest. However, herbicide usage data were not compiled by individual national forests prior to the injunction, nor have surveys of usage been conducted. Data are contained only in individual spray records for the 19 forests in the northwest region, and are not readily available. Newly available pesticides as well as those used prior to 1982 (listed in Table 17) could be used in the future, pending approval of a final environmental impact statement tentatively scheduled for September 1988 (USDA 1987).

4.1.4 Urban Use

It is estimated that the urban sector has the highest rate of pesticide usage in the basin (see Table 6). Basin-wide urban usage is approximately one-half total pesticide usage for all categories, and 3 times agricultural use. However, there is a high degree of uncertainty in these data. Urban pesticide usage data in the basin are not compiled by WSDA, the agency responsible for maintaining pesticide registrations in the state, nor are they compiled by any other governmental agency. Furthermore, no surveys, local, state, or national, have been conducted on urban pesticide use during the past 10 yr.

TABLE 17. FOREST SERVICE HERBICIDES USE BEFORE 1982 IN THE PACIFIC NORTHWEST

	Herbicide	Approximate Percent of Treated Acreage
Major use	2,4-D	38
	Glyphosate	31
	Picloram	8
	Triclopyr	7
Minor use: (In order of approximate usage)	Dalapon	< 5
	Atrazine	< 5
	2,4-DP	< 5
	Hexazinone	< 5
	Fosamine	< 5
	Dicamba	< 5
	Asulam	< 5
	Tebuthiuron	< 5
	Diuron	< 5
	Simazine	< 5
	Bromacil	< 5
	Amitrole	< 5

Source: U.S. Forest Service Draft Environmental Impact Statement (USDA 1987).

Because of the lack of current surveys of urban pesticide usage in the Puget Sound basin, much of the data were extrapolated from sources that were outside the basin. This method of estimation assumes that the pesticide usage rates and methods and purposes of application are similar for the two geographical areas and remain fairly constant over time. These assumptions have been detailed in Section 2.2.5. The latter assumption in particular may be invalid since household pesticide usage is a rapidly changing market compared to other pesticide uses (Ridgley 1982).

4.1.5 Private Timber Companies

Private timber company usage of pesticides has not been surveyed in the Puget Sound region, nor do government agencies compile records of usage in this sector (Wurm, D., 5 January 1988, personal communication). For this document, private timber company usage was assessed via telephone and letter requests. Approximately one-half of the small to mid-sized companies believed to hold timberland in the 12-county basin did not respond to the survey, but most of the larger timber companies responded readily. Because the data record is incomplete, the reported absence of pesticide usage on timberland may be misleading.

4.1.6 Railways

As discussed in Section 2.2.7, pesticide usage on railway right-of-ways was not quantifiable on a county-wide basis. Therefore, locations of potential entry of railway pesticides into the estuarine environment cannot be estimated. However, most of the usage of railway pesticides occurs in King, Pierce, and Thurston Counties (Johnston, D., 25 May 1988, personal communication).

4.2 ENVIRONMENTAL EFFECTS

Major concerns of the public and regulatory agencies over the persistence and damage to the environment by "historical pesticides" led to increased pesticide regulations and increased activity in research to design safer yet effective pesticides. However, it has been estimated by the

National Academy of Sciences (U.S. GAO 1986) that only 10 percent of present pesticides have been adequately tested for their environmental fate and toxicity, and that no toxicity data exists for 38 percent of all pesticides (which includes older pre-FIFRA pesticides). U.S. EPA is aware of these data gaps and has made a major effort recently to determine the environmental effects of these newer pesticides in the reregistration process.

Numerous environmental fate and toxicity data for pesticides in the Puget Sound basin were not available (Tables 9 and 10). For certain pesticides of high estimated usage in the basin (i.e., metaldehyde, sodium metaborate, butylate), the lack of data placed them in the uncertain level of concern (Table 14). A major shortcoming of the secondary sources of data used in this report (see Table A1 in Appendix A) is the lack of control over quality at the database sources. Nonetheless, these data sources adequately serve the present purpose of estimating the relative levels of concern for the pesticides used in the Puget Sound basin.

In addition, as discussed in Section 2.4.1, pesticide persistence and mobility are determined in part by characteristics of soil at the site of application, as well as application and irrigation practices and soil drainage characteristics (Spencer et al. 1985). An accurate prediction of the fate of a pesticide would need to account for local characteristics at the site of application and the physical and chemical characteristics of the pesticide. This has only been done for limited agricultural pesticides in Whatcom County (see Section 3.1).

4.3 RECOMMENDATIONS

Substantial difficulties were encountered in estimating pesticide usage in the Puget Sound basin and it is recommended that a more accurate account of the total usage of pesticides in the basin be conducted. Specifically, because of the potentially major contribution to total pesticide usage in the Puget Sound basin by the urban sector, an accurate description of real urban pesticide usage should be available to regulatory agencies and the public. At present, only pesticide manufacturers and local distributors have ready access to real usage information. A survey may be considered to remedy this information deficiency and should follow the approach and design that were described in previous surveys by U.S. EPA of select subpopulations of urban pesticide usage (von Rumker et al. 1972; Savage et al. 1980; Waddell et al. 1984). Drawbacks to this approach are that thorough surveys can become prohibitively labor intensive, are fraught with problems because of the large scope and frequently reluctant participants, and are usually supplemented with multiple in-depth personal interviews with representative users of each subgroup (Waddell et al. 1984).

An alternative method for tracking pesticide usage that is highly accurate and much easier to conduct than the standard survey method is for the State of Washington to require either all users or all suppliers (distributors or manufacturers) of pesticides to provide data to WSDA on pesticide usage for each major user group. Although potentially difficult to institute politically and difficult for users to comply with, this method has been used for several years by CDFA for both crop and non-crop commodities (CDFA 1986).

Lastly, the numerous monitoring and sampling programs in the Puget Sound basin are deficient in data on the potential contamination by contemporary pesticides (as compared with "historical pesticides" such as DDT) in the basin environment (see Section 3.2). Considering the widespread usage of pesticides in the basin, a substantially more extensive reconnaissance survey is recommended for contemporary pesticides. This recommendation is addressed in the following section.

5.0 RECOMMENDATIONS FOR A SAMPLING STRATEGY FOR PUGET SOUND PESTICIDES

The final objective of this report is to recommend items for consideration in designing a sampling strategy for pesticides of concern in the Puget Sound basin. As discussed in the previous section, there are no ongoing monitoring programs that sample for contemporary pesticides. The recommendations presented herein are intended to help fill this large data gap with respect to ambient pesticide concentrations. The considerations recommended below are based on pesticide usage patterns, both spatial and temporal, and the potential for pesticide migration from the source of application to the aquatic environments of the basin. Where quantitative data on pesticide contamination of the sound are available, they are presented for reference purposes only.

Pesticide usage throughout the Puget Sound basin has been identified and estimated herein by various methods, with varying degrees of accuracy. For pesticides with documented data on location and rate of usage, specific considerations in designing a sampling strategy can be readily recommended. For the remaining pesticides, more general recommendations are presented.

5.1 GENERAL RECOMMENDATIONS

5.1.1 Media Identification

The medium in which a pesticide is most likely to occur can guide sampling strategies. For example, pesticides of primary concern that are highly persistent and are expected to bind tightly to particulate matter should be sampled in sediments or particulates suspended in the water column. Such pesticides are listed under the primary concern category in Table 14 as "Sediments/Organic Particulates". These pesticides are more likely to occur bound to fine particulates after a heavy rainfall accompanied by significant soil translocation. Pesticides with high usage, high water solubility, and low persistence, should be sampled only in riverine systems and drainages proximal to the site of application since they would not be expected to migrate far from the site of application before degradation. Pesticides indicated in Table 11 as having persistent degradation products should also be considered during the development of a sampling plan.

5.1.2 Analytical Concerns

For many pesticides, analytical protocols for environmental samples are not readily available. Customized analytical methods may be available through private laboratories for some pesticides not included in the U.S. EPA test methods (U.S. EPA 1988). The following rationale may be useful as a preliminary screening of analytical methods based on sensitivity of detection. According to U.S. EPA (U.S. EPA 1986c), pesticides that result in residues in either freshwater or estuarine/marine environments exceeding one-tenth the LC_{50} value for nontarget organisms will be candidates for restricted use. Acceptable nontarget organisms include, but are not restricted to, those organisms listed in Table 10 under "Freshwater LC_{50}" and "Marine LC_{50}." It is recommended that detection limits for pesticides considered in a reconnaissance survey of the sound be at most one-tenth the LC_{50} values listed in Table 10.

5.1.3 Geographical Locations

Sampling station locations should be selected on the basis of spatial usage patterns (see Section 2.3). Heaviest usage of the major pesticides occurs in the major urban and agricultural counties of Pierce, King, Snohomish, Whatcom, and Skagit, in descending order. The remaining counties of the Puget Sound basin are either heavily forested or primarily rural environments and contribute to total usage primarily as "hot spots" of certain pesticides. Pesticide sampling plans should focus on areas of Puget Sound near major drainages of the two urban counties, King and Pierce, and on riverine and marine environments of the three agricultural counties, Whatcom, Skagit, and Snohomish (see Section D.1 for discussion of urban pesticide sources and transport to the natural environment). Since a major portion of the watershed drains into the Whidbey basin (Section 2.3), an overall sampling program should include several stations adjacent to Skagit

Bay, Port Susan, and Possession Sound, and samples collected there should be analyzed for pesticides used in the agricultural counties.

The reference site should be located in an area having the least potential for contamination based on pesticide usage patterns. Potential reference sites (i.e., ones that are removed from agricultural, urban, and major forestry pesticide uses, and drain small watershed basins) are Discovery and Dabob bays (see Figure 3).

5.1.4 Temporal Considerations

Ambient pesticide concentrations are likely to vary seasonally. The range of concentrations can be identified by sampling during periods of minimum and maximum use. Where possible, sampling for minimum use should be delayed after the last application period to allow for pesticide degradation. Urban and agricultural uses occur primarily during May and June, and continue through summer. Certain timberland pesticides are applied in the fall, and preemergent herbicides are applied by commercial applicators and agriculture in March (see Table B2 in Appendix B for identification of these pesticides). To determine background concentrations of pesticides, it is recommended that sampling take place in February, after a relatively dry period. This timing will avoid the fall applications of timberland herbicides and the March herbicide applications. A major sampling effort should then occur in June or July, both before a rainfall and immediately after a heavy rainfall with anticipated soil translocation (to detect soil-bound pesticides). This sampling schedule is designed to monitor a "worst case" release of pesticides to the aquatic environment.

5.1.5 Sampling of Biota

Samples of biological tissue from Puget Sound have generally not been analyzed for pesticides currently in use in the Puget Sound basin. Animal species that could bioaccumulate these pesticides have not been identified, although mussels offshore California have been found to bioaccumulate TBT (Beaumont and Budd 1984). It is recommended that biological sampling follow the monitoring strategy proposed in the U.S. EPA monitoring plan for Puget

Sound (Tetra Tech 1986). Several species are recommended for sampling in this plan, including one bottomfish species, two recreational fishes, and shellfish. A sampling strategy for freshwater fish should follow the guidelines outlined by Ecology (Hopkins et al. 1985) (i.e., at least one grazer and one higher order predator). Sampling should be scheduled during the period of heavy pesticide usage and the period of maximum fat accumulation in fish. Fish tissue samples should be analyzed for primary concern pesticides having the greatest potential to bioaccumulate. These pesticides have been listed in Table 14 under "Biological Tissue."

It is recommended that biological sampling include marine birds and mammals since they represent higher trophic levels with the greatest potential for bioaccumulation of chemicals. Although they are difficult to capture, great blue herons *(Ardea herodias)* have been suggested because of past accumulation of DDT in their tissues (Norman et al. 1988). Populations known to feed near the watershed drainages of agricultural counties and Pierce County may be considered. Another potential target species is harbor seals *(Phoca vitulina)*, which are relatively nonmigratory and, in certain populations in southern Puget Sound, have detectable levels of DDE (the major persistent metabolite of DDT) in their tissue (Calambokidis et al. 1988). As recommended in the proposed monitoring plan for Puget Sound (Tetra Tech 1986), public resentment against the sacrifice of marine birds and mammals should be considered before selecting them as monitoring species.

5.2 SPECIFIC RECOMMENDATIONS

Specific locations of high pesticide usage are identifiable in the basin and should be accounted for in designing a sampling strategy. The following are pesticides, media, and geographical locations that may be considered.

- TBT is expected to concentrate in sediments and waters of those areas with heaviest boating usage, including urban harbors and the recreational lakes. Since its use in Washington has recently been restricted (see Section D.6.2), environmental contamination by TBT is not anticipated to increase in the future.

- 2,4-D is most heavily used in Pierce, King, Skagit, and Snohomish counties. Although 2,4-D esters and salts make up the bulk of 2,4-D usage, they are rapidly hydrolyzed in water to 2,4-D acid. Sampling for 2,4-D acid should be performed in urban drainages in King and Pierce counties, and rivers and watershed outlets of the agricultural counties (Skagit, Snohomish). 2,4-D has been detected in Padilla Bay (Skagit County) at levels up to 1.3 ug/L in water samples (Mayer 1987). LC_{50} values for marine shrimp and fish are 2 and 5 mg/L, respectively (see Table 10).

- Dicamba is expected to be present in waters (riverine and marine) and sediments in King, Pierce, Skagit, and Snohomish counties. It is widely used in urban and rural areas and has been detected in Padilla Bay at levels up to 170 ug/L in waters and 17.1 mg/kg in sediments (dry weight) (Mayer 1987). Dicamba LC_{50} for marine shrimp is greater than 100 mg/L (see Table 10).

- Prometon has low mobility potential, but because it is widely used and persistent in soils it may be detectable in sediments off Whatcom, King, Pierce, and Mason counties (primarily applied by Bonneville Power Administration, U.S. Department of Energy).

- Simazine is used largely in Mason, King, and Pierce counties, and is expected to accumulate in sediments of major drainages. Its use in Mason County is on agricultural crops and the specific drainage location (rivers, southern Puget Sound or Hood Canal, Figure 3) cannot be determined.

- Triclopyr has a low persistence and moderate to low toxicity, and is not expected to be detectable in Puget Sound. However, its high mobility and high usage at the Fort Lewis Army Base are considerations for its potential presence in riverine waters in Pierce County, principally the drainages of the base (e.g., the Nisqually River).

- Bromacil usage is heavy in Island and Pierce counties, and may be present in waters of their major drainages. The sampling location in marine waters of Island County should lie in proximity to the drainages of the naval installation, its major user.

- Diuron usage is heavy in Island County at the naval installation. It has a moderate persistence and binds to soils and may be present in sediments in proximity to the drainages of the installation.

- Pronamide usage is heavy in Mason County. It adheres to soils, is relatively persistent, and may be present in sediments of riverine and marine environments in the county.

- Atrazine usage is somewhat greater in King County than other counties. It has low water solubility, but has been detected in Chesapeake Bay (up to 45 ug/L) after heavy rainfall (Kemp et al. 1983) and may follow similar transport patterns in Puget Sound.

- Tebuthiuron usage is heavy in Whatcom and King counties (Bonneville Power Administration, U.S. Department of Energy) and, although its toxicity is fairly low, it is water soluble and relatively persistent, and may be present in aquatic environments in these counties.

- Malathion has low water solubility and is rapidly hydrolyzed in water, but it, or its degradation products (Table 11), may be detectable in urban drainages proximal to its site of maximal usage (Fort Lewis Army Base) in Pierce County.

- Both Skagit and Snohomish counties have high usages of agricultural-specific pesticides:
  - Alachlor and phorate are moderately persistent and would most likely occur in sediments.
  - Dinoseb, methamidophos, and propham are moderately to highly mobile, but have low persistence and may not migrate to the aquatic environment. Their potential is greatest for riverine environments in Skagit County proximal to sites of agricultural application.
  - Trifluralin has low mobility and moderate persistence, but high bioaccumulation potential and toxicity. Although not expected to migrate to the aquatic environment, it may be of concern in sediments of Skagit County proximal to sites of application.
  - Butylate has moderate persistence, low mobility, and uncertain toxicity, but may be present in aquatic sediments of Skagit County, proximal to its major location of use.
- Consideration should be given to including pesticide degradation products listed in Table 11 as indicators of pesticide contamination of Puget Sound. However, whether these compounds are expected to be present and stable in aquatic environments is not certain since most tend to be less mobile (i.e, stronger adherence to soils) than the parent compound. The pesticides whose metabolites may be expected to persist in soils at the site of application, and then to be transported into other environments during heavy rainfall, include triclopyr, diuron, phorate, disulfoton, chlorothalonil, aldrin, and endosulfan. Since carbaryl is widely used in the basin, and its major metabolite is more toxic

(see Table 11), consideration should be given to sampling for that metabolite in both sediments and waters of the basin.

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APPENDIX A

PESTICIDE INFORMATION SOURCES

APPENDIX A: PESTICIDE INFORMATION SOURCES

The following tables are a compendia of sources that were consulted for pesticide usage, environmental fate, and toxicity information.

TABLE A1. GENERAL SOURCES FOR PESTICIDE USAGE AND ENVIRONMENTAL EFFECTS INFORMATION

Pesticide Usage Surveys	
Federal government	Freimark 1985
Households	Dewell 1987 Ridgley 1982 Savage et al. 1980 von Rumker et al. 1972
Cities/public schools	Dreistadt et al. 1984
Public schools	Bush 1986 Bush and Sweet 1987
Commercial applicators	Waddell et al. 1984
Pesticide Databases	
Agricultural usage	Gianessi 1986 Sacha et al. 1986
Environmental fate/toxicity	Mayer and Ellersieck 1986 U.S. EPA 1987b

The following databases are described in U.S. EPA 1986b:

- Oil and Hazardous Materials/Technical Assistance Data System (OHM/TADS), U.S. EPA
- Chemical Carinogenesis Research Information System (CCRIS), National Institutes of Health (NIH)
- Hazardous Substances Data Bank (HSDB), National Library of Medicine (NLM)
- Registry of Toxic Effects of Chemical Substances (RTECS), National Institute for Occupational Safety and Health (NIOSH)
- National Pesticide Information Retrieval System (NPIRS), Purdue University
- Environmental Fate Databases, Syracuse Research Corporation

TABLE A1. (Continued)

Pesticide Compendia	
General usage	CDFA 1980, 1986
Targeted uses/effects/toxicities	Worthing and Walker 1987 Capizzi et al. 1987 U.S. EPA 1987a Meister 1986 Ware 1978 Cooperative Extension 1982 Sassaman et al. 1986 Sassman et al. 1984 Johnson and Finley 1980
Pesticide Reviews	
Chemical properties	Lyman et al. 1982
Environmental properties	Residue Reviews 1987 Matsurmura and Murti 1982 Ghassemi et al. 1981 Khan 1980 Hague and Freed 1975 Edwards 1970 Overcash and Davidson 1980 Brown 1978 Rajagopal et al. 1984 Seiber 1987
Aquatic toxicity	Murty 1986 Eaton et al. 1980 Johnson and Finley 1980 Gunther and Gunther 1984
Herbicides	Frear 1976
Directories	
Water resources in Puget Sound	Hertz et al. 1973
Timber companies	Mendoza 1987-1988
Washington State agencies	Yates and Yates 1985

TABLE A2. GOVERNMENT AGENCY SOURCES[a]

Federal	
U.S. Environmental Protection Agency (EPA)	Seattle, WA
National Oceanic and Atmospheric Administration (NOAA, Department of Commerce)	Seattle, WA
U.S. Department of Agriculture, Forest Service Pacific Northwest Region	Portland, OR
U.S. Department of Navy	Seattle, WA Bremerton, WA
U.S. Air Force	McChord AFB, WA
Occupational Safety and Health Administration (OSHA)	Seattle, WA
U.S. International Trade Commission	Washington, DC
State of Washington	
Dept. of Agriculture (WSDA)	Olympia, WA
Dept. of Ecology (Ecology)	Olympia, WA
Dept. of Transportation (WDOT)	Olympia, WA
Dept. of Natural Resources (WDNR)	Olympia, WA
Dept. of Wildlife (WDOW)	Olympia, WA
Dept. of General Administration State Purchasing Division	Olympia, WA
Cooperative Extension Service	Pullman, WA
Puget Sound Water Quality Authority (PSWQA)	Seattle, WA
Utilities and Transportation Commission	Olympia, WA
State of California	
Dept. of Food and Agriculture Pest Management Division	Sacramento, CA

TABLE A2. (Continued)

County	
Dept. of Public Works	Puget Sound Counties (x12)
Cooperative Extension Service	King County, WA
Local	
Municipality of Metropolitan Seattle (Metro)	Seattle, WA
City Light	Seattle, WA
Health Dept.	Seattle, WA
Dept. of Public Works	Representative Local Cities
Dept. of Parks	Representative Local City Parks

[a] These agencies were contacted for pesticide usage and environmental effects information.

TABLE A3. TRADE AND PROFESSIONAL ASSOCIATIONS[a]

Washington Forest Protection Assoc.	Tacoma, WA
International Pesticide Applications Assoc.	Puyallup, WA
National Pesticide Control Assoc.	Washington, DC
National Agricultural Chemical Assoc.	Washington, DC
Chemical Specialties Manufacturers Assoc.	Washington, DC
Chemical Production and Distribution Assoc.	Washington, DC
Washington Railroad Association	Seattle, WA

[a] Contacted for usage and environmental effects information.

TABLE A4. NON-PROFIT INFORMATIONAL ORGANIZATIONS[a]

Washington Friends of Farm and Forestry	Olympia, WA
Greenpeace	Seattle, WA
Western Washington Toxics Coalition	Seattle, WA
National Coalition Against the Misuse of Pesticides	Washington, DC
Resources for the Future (RFF)	Washington, DC
National Coalition for Alternatives to Pesticides	San Francisco, CA
Citizens for a Better Environment	San Francisco, CA

[a] Contacted for usage and environmental effects information.

APPENDIX B

PESTICIDE USES AND CHEMICAL/TRADE NAMES

APPENDIX B: PESTICIDE USES AND CHEMICAL/TRADE NAMES

The following tables provide a trade name cross-index and list pesticide uses, chemical names, and respective basic manufacturers.

TABLE B1. PESTICIDE TRADE NAME CROSS INDEX

Synonyms*/Trade Names	Active Ingredient	Synonyms*/Trade Names	Active Ingredient
Aatack, Several	Thiram	Chem-Hoe*, IPC	Propham
Aatrex, Drexel	Atrazine	Chipco 26019, Rovral	Iprodione
Abate	Temephos	Chlorflurecol*, Maintain, Multiprop	Chlorflurenol
Accelerate, Desi-cate	Endothall	Chlorthal-Dimethyl, Dacthal	DCPA
Alfosid, Several	Methoprene	Copper Nordox*	Cuprous Oxide
Alvit, Dieldrex	Dieldrin	Coumafene, Zoocoumarin	Warfarin
Al-Phos, Celphine, several	Aluminum Phosphide	Cross Fire, Synthrin, SBP-1382	Resmethrin
Ambush, Ectiban, Pounce, Pramex	Permethrin	Cube*, Derris, Nox Fish, Chem Fish	Rotenone
Amiben, Vegiben	Chloramben	Cuprinol, Troysan	Copper Naphthenate
Amitrole-T*, Several	Amitrole	Cythion	Malathion
Ammate	Ammonium Sulfamate	Daconil, Bravo	Chlorothalonil
Ansar 529, Byeno, Methylarsonic Acid*	MSMA	Dacthal, Chlorthal-Dimethyl	DCPA
Ansar 8100, Arrhenal, Dimethylarsonic Acid*	DSMA	DDVP*, Vapona	Dichlorvos
Antimilace, Halizan, Metason	Metaldehyde	Delnav, Deltic	Dioxathion
Aqualin	Acrolein	Deltic, Delnav	Dioxathion
Aquazine, Princep	Simazine	Derris, Nox Fish, Chem Fish, Cube*	Rotenone
Arrhenal, Dimethylarsonic Acid*, Ansar 8100	DSMA	Desi-cate, Accelerate	Endothall
Aspor, Zineb, Dithane	Zineb	Devrinol	Napropamide
Avitrol*	Aminopyridine	Dibrom	Naled
Azodrin	Monocrotophos	Dieldrex, Alvit	Dieldrin
Balan, Benefin*	Benfluralin	Difolatan	Captafol
Banex, Bush Buster, Banvel	Dicamba	Dimethylarsonic Acid*, Ansar 8100, Arrhenal	DSMA
Banvel, Banex, Bush Buster, Weed Master	Dicamba	Dimethylarsinic Acid*, Bolls-Eye, Broadside	Cacodylic Acid
Baygon	Propoxur	Dinitro, Vertac, DNBP*	Dinoseb
Baytex, Entex, Tiguvon	Fenthion	Dipel, Thuricide, Biotrol K	Bacillus Thuringiensis
Benefin*, Balan	Benfluralin	Dipterex, Dylox, Neguvon, Proxol	Trichlorfon
Benlate, Tersan	Benomyl	Dithane M-22, Manzate	Maneb
Betasan, Prefar	Bensulide	Dithane M-45, Karamate	Mancozeb
Biotrol K, Dipel, Thuricide	Bacillus Thuringiensis	Dithane, Aspor, Zineb	Zineb
Bladafum	Sulfotep	Di-Syston	Disulfoton
Bolls-Eye, Broadside, Dimethylarsinic Acid*	Cacodylic Acid	DNBP*, Dinitro, Vertac	Dinoseb
Boracic acid*	Boric Acid	Dowpon	Dalapon
Borax*, Monoborchlorate, Ureabor	Sodium Metaborate	Drexel, Aatrex	Atrazine
Bravo, Daconil	Chlorothalonil	Drinox, Termide	Heptachlor
Broadside, Dimethylarsinic Acid*, Bolls-Eye	Cacodylic Acid	Dual	Metolachlor
Brominal, Buctril, Nu-Lawn	Bromoxynil	Dursban, Lorsban	Chlorpyrifos
Bromo-Gas, Terr-O-Gas	Methyl Bromide	Dylox, Neguvon, Proxol, Dipterex	Trichlorfon
Buctril, Nu-Lawn, Brominal	Bromoxynil	Dymid, Enide	Diphenamid
Bush Buster, Banvel, Banex	Dicamba	D-D, Telone	Dichloropropene
Butacide	Piperonyl Butoxide	Ectiban, Pounce, Pramex, Ambush	Permethrin
Byeno, Methylarsonic Acid*, Ansar 529	MSMA	Embark	Mefluidide
Carbon Bisulfide*	Carbon Disulfide	Endrex	Endrin
Casoron	Dichlobenil	Enide, Dymid	Diphenamid
Celphine, Al-Phos, Several	Aluminum Phosphide	Entex, Tiguvon, Baytex	Fenthion
Chem Fish, Cube*, Derris, Nox Fish	Rotenone	Esteron, Several, Weedar	2,4,5-T

TABLE B1. (Continued)

Synonyms*/Trade Names	Active Ingredient	Synonyms*/Trade Names	Active Ingredient
Fermate	Ferbam	Nox Fish, Chem Fish, Cube*, Derris	Rotenone
Fervinal, Poast, Nabu	Sethoxydim	Nu-Lawn, Brominal, Buctril	Bromoxynil
Ficam, Tattoo	Bendiocarb	Octachlor, Termide	Chlordane
Folidol, Metacide	Methyl Parathion	Octalene	Aldrin
Furadan	Carbofuran	Orthene	Acephate
Gamma HCH*, Several	Lindane	Oust	Sulfometuron-methyl
Garlon 3A, Garlon 4	Triclopyr	PCP*, Penta*	Pentachlorophenol
Garlon 4, Garlon 3A	Triclopyr	Penncap-E, Several, Niran	Parathion
Glean, Telar	Chlorsulfuron	Penta*, PCP*	Pentachlorophenol
Goal	Oxyfluorfen	Phosdrin	Mevinphos
Guthion	Azinphos-methyl	Plantvax	Oxycarboxin
Halizan, Metason, Antimilace	Metaldehyde	Poast, Nabu, Fervinal	Sethoxydim
Hyvar	Bromacil	Polyram, Polyram-Combi	Metiram
IPC, Chem-Hoe*	Propham	Polyram-Combi, Polyram	Metiram
Karamate, Dithane M-45	Mancozeb	Pounce, Pramex, Ambush, Ectiban	Permethrin
Karmex, Krovar	Diuron	Pramex, Ambush, Ectiban, Pounce	Permethrin
Kelthane	Dicofol	Pramitol	Prometon
Kerb, Propyzamide*	Pronamide	Prefar, Betasan	Bensulide
Knox-Out, Spectracide	Diazinon	Princep, Aquazine	Simazine
Krenite	Fosamine Ammonium	Propal, Mecoprop*	MCPP
Krovar, Karmex	Diuron	Propyzamide*, Kerb	Pronamide
Lannate	Methomyl	Proxol, Dipterex, Dylox, Neguvon	Trichlorfon
Lasso	Alachlor	Pydrin	Fenvalerate
Lexone, Sencor	Metribuzin	Pyrenone, Pyrocide, Pyrethrum*	Pyrethrins
Lorox	Linuron	Pyrethrum*, Pyrenone, Pyrocide	Pyrethrins
Lorsban, Dursban	Chlorpyrifos	Pyrocide, Pyrethrum*, Pyrenone	Pyrethrins
Maintain, Multiprop, Chlorflurecol*	Chlorflurenol	Quintozene*, Terraclor	PCNB (Quintozene)
Manzate, Dithane M-22	Maneb	Reglone, Weedol	Diquat
Mecoprop*, Propal	MCPP	Ronstar	Oxadiazon
Metacide, Folidol	Methyl Parathion	Roundup	Glyphosate
Metam-Sodium*, Metham*, Vapam	Metam	Rovral, Chipco 26019	Iprodione
Metason, Antimilace, Halizan	Metaldehyde	Safrotin	Propetamphos
Metasystox-R	Oxydemeton-methyl	SBP-1382, Cross Fire, Synthrin	Resmethrin
Metham*, Vapam, Metam-Sodium*	Metam	Sencor, Lexone	Metribuzin
Methyl Bromide, Several	Chloropicrin	Several	2,4-D
Methylarsonic Acid*, Ansar 529, Byeno	MSMA	Several	Sodium Chlorate
MH (WSSA)*, MH-30	Maleic Hydrazide	Several	Sulfur
MH-30, MH (WSSA)*	Maleic Hydrazide	Several	TriButylTin
Monitor, Tamanox	Methamidophos	Sevin	Carbaryl
Monoborchlorate, Ureabor, Borax*	Sodium Metaborate	Sinbar	Terbacil
Multicide, Sumithrin	Phenothrin	Spectracide, Knox-Out	Diazinon
Multiprop, Chlorflurecol*, Maintain	Chlorflurenol	Spike	Tebuthiuron
Nabu, Fervinal, Poast	Sethoxydim	Sumithrin, Multicide	Phenothrin
Neguvon, Proxol, Dipterex, Dylox	Trichlorfon	Surflan	Oryzalin
Nemacur	Fenamiphos	Sutan	Butylate
Niran, Penncap-E, Several	Parathion	Synthrin, SBP-1382, Cross Fire	Resmethrin

TABLE B1. (Continued)

Synonyms*/Trade Names	Active Ingredient	Synonyms*/Trade Names	Active Ingredient
Tamanox, Monitor	Methamidophos	Ureabor, Borax*, Monoborchlorate	Sodium Metaborate
Tattoo, Ficam	Bendiocarb	Van Dyke 264	Octyl bicycloheptene-carboximide
Telar, Glean	Chlorsulfuron		
Telone, D-D	Dichloropropene	Vapam, Metam-Sodium*, Metham*	Metam
Telvar	Monuron	Vapona, DDVP*	Dichlorvos
Temik	Aldicarb	Vegiben, Amiben	Chloramben
Terbalin, Treflan	Trifluralin	Velpar	Hexazinone
Termide, Drinox	Heptachlor	Vernam	Vernolate
Termide, Octachlor	Chlordane	Vertac, DNBP*, Dinitro	Dinoseb
Terraclor, Quintozene*	PCNB (Quintozene)	Vikane	Sulfuryl Fluoride
Terr-O-Gas, Bromo-Gas	Methyl Bromide	Volck Oils	Dormant Oil
Tersan, Benlate	Benomyl	Weed Master	Dicamba
Thimet	Phorate	Weedar, Esteron, Several	2,4,5-T
Thiodan	Endosulfan	Weedol, Reglone	Diquat
Thuricide, Biotrol K, Dipel	Bacillus Thuringiensis	Weedol, Several	Paraquat
Tiguvon, Baytex, Entex	Fenthion	Xylol	Xylene
Tordon	Picloram	Zineb, Dithane, Aspor	Zineb
Treflan, Terbalin	Trifluralin	Ziram Tech.	Ziram
Troysan, Cuprinol	Copper Naphthenate	Zoocoumarin, Coumafene	Warfarin

TABLE B2. PESTICIDE USES

Classification	Active Ingredient	Uses	Targets of Use
Anilides	Alachlor	Herbicide	Preemergence control of grass, broad-leaf weeds.
	Metolachlor	Herbicide	Preemergence, preplant in corn, peanuts, soybeans, others.
Anilines	Benfluralin	Herbicide	Annual grasses and broad-leaf weeds.
	Propham	Herbicide	Pre-, postemergence weed control.
Benzimidazoles	Benomyl	Fungicide/Bactericide	Systemic control of fruit, vegetable, nut, field crop, turf, ornamental diseases.
	Oxycarboxin	Fungicide/Bactericide	Systemic control of rusts on greenhouse flowers.
Benzoic Acids	Chloramben	Herbicide	Preemergence weed control in many vegetable, field crops.
	DCPA	Herbicide	Preemergence control of grass, broad-leaf weeds.
	Dicamba	Herbicide	Control of annual, perennial weeds and brush in non-crop areas.
Bipyridiliums	Paraquat	Herbicide	Contact herbicide and desiccant with broad scope of uses.
	Diquat	Herbicide	Industrial and aquatic weed control; seed crop desiccant.
Botanicals	Rotenone	Insecticide	Home gardens, pets; fish control in ponds, lakes.
Carbamates	Aldicarb	Insecticide/Acaracide	Systemic insecticide, acaricide and nematicide, soil-applied only.
	Bendiocarb	Insecticide	Control of household insects; turf, ornamentals; soil insects.
	Carbofuran	Nematicide/Insecticide	Controls wide range of soil and foliar pests.
	Ferbam	Fungicide/Bactericide	Apple and tobacco diseases; protectant for other crops.
	Propoxur	Insecticide	Household crawling insects, files, mosquitos, lawn insects.
	Zineb	Insecticide/Acaracide	Variety of fruits and vegetables uses.
	Carbaryl	Insecticide/Acaracide	Great range of controlling pests.
	Methomyl	Insecticide	Control of wide range of insects in fruit crops.
Carboxylic Acids	Chlorflurenol	Herbicide	Control of broadleaf weeds, vines, and grasses.
Chlorinated Cyclodienes	Aldrin	Insecticide	Contact, stomach and fumigant insecticide.
	Chlordane	Insecticide	Exclusively for subterranean termite control applications.
	Dieldrin	Insecticide	Contact and stomach poison. For control of soil insects, termites.
	Endosulfan	Insecticide	Nonsystemic contact and stomach insecticide.
	Endrin	Insecticide	Cotton insect control and a few other crops; mouse control in orchards.
	Heptachlor	Insecticide	Residual control of subterranean termites.
Coumarins	Warfarin	Rodenticide	Anticoagulant control of Norway rats and house mice.
Dicarboximides	Octyl bicycloheptene-carboximide	Synergist	Synergist for pyrethroids.
	Iprodione	Fungicide/Bactericide	Spring and summer turf diseases. Experimental for fruits, vegetables.
	Captafol	Fungicide/Bactericide	Many diseases of fruits, vegetables, nuts, seeds.
Halogenated Hydrocarbons	Dalapon	Herbicide	Systemic herbicide for various grasses and rushes in crop, noncrop areas.
	Dichloropropene	Insecticide/Acaracide	Soil-injected fumigant to control nematodes, soil insects.
	Dicofol	Acaricide	Wide use as acaricide on fruit, vegetable, field, ornamental crops.
	Lindane	Insecticide/Acaracide	Many uses including seed treatment; moderate fumigant action.
	Methyl Bromide	Insecticide/Acaracide	Fumigant to control all living matter.
	Methylene Chloride	Insecticide/Acaracide	Postharvest fumigation of strawberries, commodity fumigation of grains.
Heterocyclic Nitrogens	Maleic Hydrazide	Herbicide	Retards growth and inhibits sprouting of plants; blocks cell division.
	Oxadiazon	Herbicide	Pre-, postemergence weed control in rice; for weeds in turf, ornamentals.
Hormone	Methoprene		
Inorganics	Aluminum Phosphide	Insecticide	Fumigant in bulk grain and peanuts, processed food and animal feed.
	Ammonium Sulfamate	Herbicide	Control of woody plant species.
	Boric Acid	Insecticide	Cockroach baits and ant poisons, in sheep dressings to prevent blowfly attacks.
	Cuprous Oxide	Pesticide	Seed treatment and antifouling agent in paints.

TABLE B2. (Continued)

Classification	Active Ingredient	Uses	Targets of Use
Inorganics	Lime Sulfur	Fungicide/Bactericide	Apple scab, powdery skin irritation mildews.
	Sodium Chlorate	Herbicide	Soil sterilant herbicide, defoliant, desiccant, harvest aid.
	Sodium Metaborate	Herbicide	Non-selective herbicide; fire retardant added to sodium chlorate.
	Sulfur	Fungicide/Bactericide	Fruit rots, powdery mildews, rusts on vegetables.
	Sulfuryl Fluoride	Insecticide/Acaracide	Fumigant to control structural pests, especially drywood termites.
Inorganic-organics	Copper Naphthenate	Fungicide	Disinfectant wood treatment.
	TriButylTin	Pesticide	Preservation against molds, yeasts, and slimes; antifouling agent in paints.
Microbial	Bacillus Thuringiensis	Insecticide	Control of caterpillar pests on most food crops.
Miscellaneous Organics	Acrolein	Herbicide	Aquatic herbicide, biocide, slimicide.
	Carbon Disulfide	Insecticide/Acaracide	Widely used fumigants for insect control in stored grain.
	Chloropicrin	Insecticide/Fungicide	Stored grain and soil fumigant.
	Dioxathion	Insecticide/Acaracide	Control of insects, mites on fruit and nut trees, ornamentals; also for livestock pests.
	Dormant Oil	Insecticide/Acaracide	Control of scale insects, aphid, spider mite eggs; livestock parasiticide.
	Mefluidide	Herbicide	Plant growth regulator to prevent seedhead formation in turf grasses.
	Metaldehyde	Molluscicide	Snail and slug bait.
	Oxyfluorfen	Herbicide	Pre-, postemergence control of broad weeds.
	Piperonyl Butoxide	Synergist	Synergist for pyrethrins, synthetic pyrethroids.
	Pronamide	Herbicide	Pre-, postemergence weed control; also on turf, woody ornamentals.
	Sethoxydim	Herbicide	Selective postemergence control of annual and perennial grasses.
	Xylene	Additive	Solvent of dieldrin, methyl parathion.
	Endothall	Herbicide	Weed control, turf; aquatic herbicide; cotton defoliant; seedcrop desiccant.
Nitriles	Bromoxynil	Herbicide	Postemergence broad-leaf weed control in small grains, noncrop areas.
	Chlorothalonil	Fungicide/Bactericide	Variety of vegetable, fruit, turf, ornamental diseases.
	Dichlobenil	Herbicide	Selective weed control in ornamentals, orchards, vineyards.
Nitroanilines	Trifluralin	Herbicide	Selective preemergence incorporated herbicide registered for many crops.
Organic Arsenicals	Cacodylic Acid	Herbicide	Nonselective herbicide in forestry; cotton defoliant.
	DSMA	Herbicide	Postemergent use in cotton as a directed spray on weeds.
	MSMA	Herbicide	Preplant for cotton, grass weeds in turf, noncropland.
Organophosphates	Acephate	Insecticide	Control of most insects on vegetables, cotton, soybeans.
	Azinphos-methyl	Insecticide	Control of most foliage-feeding insects on many crops.
	Bensulide	Herbicide	Preemergence control of crabgrass, annual bluegrass, broad-leaf weeds.
	Chlorpyrifos	Insecticide	Household insects, ornamental pests; soil insects, fruit trees; termite control.
	Diazinon	Insecticide	Soil insects, pests of fruit, vegetables, field crops, ornamentals, household pets.
	Dichlorvos	Insecticide	Contact, stomach, fumigant for household, public health, livestock.
	Disulfoton	Insecticide/Acaracide	Systemic insecticide, acaricide on cotton, potatoes, other crops.
	Fenamiphos	Nematicide	Systemic nematicide for pre- or postemergencee application to soil.
	Fenthion	Insecticide	Contact and stomach insecticide; control of mosquitoes, flies, livestock insect pests.
	Fosamine Ammonium	Herbicide	Fall-applied brush control agent on noncropland areas.
	Glyphosate	Herbicide	Highly versatile translocated, non-selective herbicide.
	Malathion	Insecticide/Acaracide	Control of broad spectrum of insects in agriculture, public health, livestock, home, garden.
	Methamidophos	Insecticide	Control of most common insect pects on vegetables, cotton, potatoes.
	Methyl Parathion	Insecticide	Control of many insects, especially boll weevil control.
	Mevinphos	Insecticide/Acaracide	Contact and systemic insecticide for use on vegetable, fruit, field, forage crops.
	Monocrotophos	Insecticide/Acaracide	Control of most insect pests of cotton, tobacco, sugarcane, potatoes, others.
	Naled	Insecticide	Effective against chewing and sucking pests on many crops; fly and mosquito control.

TABLE B2. (Continued)

Classification	Active Ingredient	Uses	Targets of Use
Organophosphates	Oxydemeton-methyl	Insecticide/Acaracide	Control of sucking insects, mites on vegetables, fruit, hops.
	Parathion	Insecticide	Broad-spectrum insecticide on wide variety of crops.
	Phorate	Insecticide	Systemic insecticide on cotton, corn, some small grains, vegetables.
	Propetamphos	Insecticide	Effective against cockroaches, mosquitoes, fleas.
	Sulfotep	Insecticide/Acaracide	Greenhouse fumigant for aphids, mites, thrips, whiteflies.
	Temephos	Insecticide	Aquatic larvicide for mosquitoes, black flies, midges.
	Trichlorfon	Insecticide/Acaracide	Use on field crops, seed crops, ornamentals; cattle grubs, several fruits, forestry.
Phenols	Dinoseb	Herbicide	General contact herbicide, desiccant; also as a dormancy spray to control insects, mites.
	PCNB (Quintozene)	Fungicide/Bactericide	Many seedlings, vegetable, ornamental, turf diseases.
	Pentachlorophenol	Herbicide/Molluscicide	Preharvest defoliant, wood preservative, molluscicide.
Phenoxyaliphatic Acids	2,4,5-T	Herbicide	Woody plant control on industrial sites rangeland.
	2,4-D	Herbicide	Selective broad-leaf weed control in monocots.
	MCPP	Herbicide	Turf, cereal herbicide for broad-leaf weeds.
Pyrethrins	Fenvalerate	Insecticide	Broad spectrum of insecticidal activity on many crops. Currently registered only on cotton.
	Permethrin	Insecticide	Cotton insects, animal health, greenhouse ornamentals.
	Phenothrin	Insecticide/Acaracide	Space sprays for homes, industry, aircraft.
	Pyrethrins	Insecticide	Fast knockdown natural insecticide; safe for household aerosols, pets, livestock.
	Resmethrin	Insecticide	Similar to pyrethrins but longer lasting, more effective.
Pyridines	Aminopyridine	Avicide	Control of variety of birds.
Pyridine-Carboxylic Acids	Picloram	Herbicide	Brush control on industrial sites, pastures, rangeland.
	Triclopyr	Herbicide	Systemic control of woody plants, broad-leaf weeds in rights-of-way.
Pyrimidines	Sulfometuron-methyl	Herbicide	Grasses and broad-leaf weeds in noncropland areas.
Substituted Amides	Diphenamid	Herbicide	Preemergence control of annual, broad-leaf weeds in many crops.
	Napropamide	Herbicide	Selective weed control in orchards, several vegetables, ornamentals.
	Oryzalin	Herbicide	Preemergence control of many weeds in soybeans, fruit, ornamentals.
Thiocarbamates	Butylate	Herbicide	Incorporated preplant for controlling grass weeds.
	Mancozeb	Fungicide/Bactericide	Wide spectrum of fruit, vegetable, field crop, nut diseases.
	Maneb	Fungicide/Bactericide	Many diseases of fruits, vegetables, turf.
	Metam	Fungicide/Herbicide	Soil fumigant for weeds, weed seeds, nematodes, fungi.
	Metiram	Fungicide/Bactericide	Many diseases of fruits, vegetables ornamentals, turf.
	Thiram	Fungicide/Bactericide	Seed treatment; diseases of fruits, vegetables, turf.
	Vernolate	Herbicide	For most common weed grasses in soybeans, peanuts.
	Ziram	Fungicide	Protective fungicide on fruit and vegetable crops; repellant.
Triazines	Atrazine	Herbicide	Season-long weed control mainly in corn, sorghum for grass control.
	Chlorsulfuron	Herbicide	Selective control of most broadleaf weeds and some annual grasses.
	Hexazinone	Herbicide	Contact and residual control of every kind of weed on noncropland areas.
	Metribuzin	Herbicide	Control of wide spectrum of weeds in several crops.
	Prometon	Herbicide	Nonselective pre-postemergence control for most weeds in noncropland.
	Simazine	Herbicide	Annual grasses, broad-leaf weeds, crops, ornamentals, turf; aquatic weed.
Triazoles	Amitrole	Herbicide	Noncropland use only, for annual, perennial grass, broad-leaf weeds.
Uracils	Bromacil	Herbicide	Weed control in noncrop area; selective weed control in citrus, pineapple.
	Diuron	Herbicide	Control germinating weeds; soil sterilant.
	Linuron	Herbicide	Selective weed control in corn, sorghum, cotton, soybeans, wheat.
	Monuron	Herbicide	Complete weed control in noncropland areas.
	Tebuthiuron	Herbicide	Total vegetation control in noncropland areas.
	Terbacil	Herbicide	Selective control of annual, some perennial.

TABLE B3. CHEMICAL NAMES AND MANUFACTURERS

Active Ingredient	CAS#	Chemical Name (IUPAC)	Basic Manufacturer
2,4,5-T	93-76-5	(2,4,5-trichlorophenoxy)acetic acid	Dow, Thompson-Hayward
2,4-D	94-75-7	(2,4-dichlorophenoxy)acetic acid. Also as salts, amines, esters.	Several
Acephate	30560-19-1	O,S-dimethyl acetylphosphoramidothioate	Chevron
Acrolein	107-02-8	2-propenal	Shell, discontinued
Alachlor	15972-60-8	2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide	Monsanto
Aldicarb	116-06-3	2-methyl-2-(methylthio)propionaldehyde, O-(methylcarbamoyl)oxime	Union Carbide
Aldrin	309-00-2	1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanononaphthalene	Shell
Aluminum Phosphide	20859-73-8	Al P	Excel Ind., Inventa Corp.
Aminopyridine	504-24-5	4-aminopyridine	Avitrol Corp.
Amitrole	61-82-5	3-amino-1,2,4-triazole	Amer. Cyanamid, Union Carb.
Ammonium Sulfamate	7773-06-0	ammonium sulfamate	duPont
Atrazine	1912-24-9	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine	Several
Azinphos-methyl	86-50-0	O,O-dimethyl S-[[4-oxo-1,2,3-benzotriazin-3(4H)-yl]methyl]phosphorodithioate	Mobay
Bacillus Thuringiensis		microbial insecticide for caterpillars	Abbott, Sandoz
Bendiocarb	22781-23-3	2,2-dimethyl-1, 3-benzodioxol-4-yl-methylcarbamate	Fisons
Benfluralin	1861-40-1	N-butyl-N-ethyl-alpha,alpha,alpha-trifluoro-2,6-dinitro-p-toluidine	Elanco Products Co.
Benomyl	17804-35-2	methyl-1-(butylcarbamoyl)-2-benzamidazole carbamate	EI duPont de Nemours & Co.
Bensulide	741-58-2	S-(O,O-diisopropyl phosphorodithioate) ester of N-(2-mercaptoethyl) benzenesulfonamide	Stauffer
Boric Acid	10043-35-3		
Bromacil	314-40-9	5-bromo-3-sec-butyl-6-methyluracil	duPont
Bromoxynil	1089-84-5	3,5-dibromo-4-hydroxybenzonitrile	Several
Butylate	2008-41-5	S-ethyldisobutylthiocarbamate	Stauffer
Cacodylic Acid	75-60-5	hydroxydimethylarsine oxide	Crystal, Vineland
Captafol	2425-06-1	cis-N(1,1,2,2-tetrachloroethyl)thio-4-cyclohexene-1,2-dicarboximide	Chevron
Carbaryl	63-25-2	1-naphthyl methylcarbamate	Union Carbide
Carbofuran	1563-66-2	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate	FMC
Carbon Disulfide	75-15-0	CS2	Stauffer Chemical Co.
Chloramben	133-90-4	3-amino-2,5-dichlorobenzoic acid	Union Carbide
Chlordane	12789-03-6	1,2,4,5,6,7,8,8-octachlor-2,3,3a,4,7,7,7a-hexahydro-4,7-methanoindane	Velsicol
Chlorflurenol	2536-31-4	2-chloro-9-hydroxyfluorene-9-carboxylate	Celamerck GmbH & Co.
Chloropicrin	76-06-2	trichloronitromethane	Several
Chlorothalonil	1897-45-6	tetrachloroisophthalonitrile	Diamond Shamrock
Chlorpyrifos	2921-88-2	O,O-diethyl O-(3,5,6-trichloro-2-pyridyl)phosphorothioate	Dow
Chlorsulfuron	64902-72-3	2-chloro-N[4-methoxy-6-methyl-1,3,5 triazin-2-yl]aminocarbonyl]-benzenesulfonamide	duPont
Copper Naphthenate	1338-02-9	copper salt of naphthenic acid	
Cuprous Oxide	1317-39-1	cuprous oxide (Cu2O), cupric oxide (CuO)	Copper Chem., Nordox
Dalapon	127-20-8	2,2-dichloropropionic acid (sodium salt)	Dow, Diamond Shamrock
DCPA	1861-32-1	dimethyl tetrachloroterephthalate	Diamond Shamrock
Diazinon	333-41-5	O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	Ciba-Geigy
Dicamba	1918-00-9	3,6-dichloro-o-anisic acid	Velsicol Chemical Corp.
Dichlobenil	1194-65-6	2,6-dichlorobenzonitrile	PBI-Gordon
Dichloropropene	542-75-6	1,3-dichloropropene	Shell
Dichlorvos	62-73-7	2,2-dichlorovinyl dimethyl phosphate	Shell
Dicofol	115-32-2	4,4'dichloro-alpha-(trichloromethyl)benzhydrom	Rohm & Haas
Dieldrin	60-57-1	(1R, 4S, 5S, 8R)-1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonaphthalene	Shell

TABLE B3. (Continued)

Active Ingredient	CAS#	Chemical Name (IUPAC)	Basic Manufacturer
Dinoseb	88-85-7	2-sec-butyl-4,6-dinitrophenol	Several
Dioxathion	78-34-2	2,3-p-dioxanedithiol S,S-bis(0,0-diethyl phosphorodithioate)	BFC Chemicals
Diphenamid	957-51-7	N,N-dimethyl-2,2-diphenylacetamide	TUCO
Diquat	85-00-7	6,7-dihydrodipyrido(1,2-alpha:2',1'-c)-pyrazinediium ion	Chevron
Disulfoton	298-04-4	0,0-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate	Mobay
Diuron	330-54-1	3-(3,4-dichlorophenyl)-1,1-dimethylurea	duPont
Dormant Oil		Petroleum oils	
DSMA	144-21-8	disodium methanearsonate	WA Cleary Corp.
Endosulfan	115-29-7	(1,4,5,6,7,7-hexachloro-8,9,10-trinorborn-5-en-2,3-ylenebismethylene)sulphite. alpha, 64-67%; beta, 29-32%	Hoechst AG
Endothall	145-73-3	7-oxabicyclo(2.2.1)heptane-2,3-dicarboxylic acid	Pennwalt
Endrin	77-20-8	1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene	Shell Int., Velsicol
Fenamiphos	22224-92-6	ethyl 3-methyl-4-(methylthio)phenyl(1-methylethyl)phosphoramidate	Mobay
Fenthion	5538-9	0,0-dimethyl 0-[4-(methylthio)-m-tolyl] phosphorothioate	Mobay
Fenvalerate	51630-58-1	(RS)-alpha-cyano-3-phenoxybenzyl(RS)-2-(4-chlorophenyl)-3-methylbutyrate	Shell
Ferbam	14484-64-1	tris(dimethylcarbamodithioato-S,S')iron	FMC
Fosamine Ammonium	25954-13-6	ammonium ethyl carbamoylphosphonate	duPont
Glyphosate	1071-83-6	N-(phosphonomethyl)glycine, isopropylamine salt	Monsanto
Heptachlor	76-44-8	1,4,5,6,7,8,8-heptachloro-3alpha,4,7,7alpha-tetrahydro-4,7-methanoindene	Velsicol
Hexazinone	51235-04-2	3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4-(1H, 3H)-dione	duPont
Iprodione	36734-19-7	3-(3,5-dichlorophenyl)-N-(1-methyl-ethyl)-2,4-dioxo=1=imidazolidinecarboxamide	Rhone-Poulenc
Lime Sulfur	1344-81-6	calcium polysulfide	Several
Lindane	58-89-9	1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer of not less than 99%	Hooker & several foreign
Linuron	330-55-2	3-(3,4-dichlorophenyl)-1-methoxyl-1-methylurea	duPont
Malathion	121-75-7	0,0-dimethyl phosphorodithioate of diethyl mercaptosuccinate	American Cyanamid
Maleic Hydrazide	123-33-1	6-hydroxy-3(2H)pyridazinone; or 1,2-dihydropyridazine-3,6-dione	Drexel Chem., Gilmore
Mancozeb	8018-01-7	coordination product of zinc ion and manganese ethylene bisdithiocarbamate	Several
Maneb	12427-38-2	manganese ethylenebisdithiocarbamate	Several
MCPP	93-65-2	2-(4-chloro-o-tolyl)oxypropionic acid, and the potassium salt	Several
Mefluidide	53780-34-0	N-[2,4-dimethyl-5-[[(trifluoromethyl)-sulfonyl]amino]phenyl]acetamide	3M
Metaldehyde	108-62-3	polymer of acetaldehyde; or r-2,c-4,c-6,c-8-tetramethyl-1,3,5,7-tetroxocane	Devidayal, Jewnin-Joffe
Metam	137-42-8	sodium N-methyldithiocarbamate	Stauffer
Methamidophos	10265-92-6	0,S-dimethyl phosphoramidothioate	Chevron, Mobay
Methomyl	16752-77-5	S-methyl N-[(methylcarbamoyl)oxy]-thioacetimidate	duPont, Shell Int.
Methoprene		isopropyl (2E-4E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate	
Methyl Bromide	74-83-9	bromomethane	Several
Methyl Parathion	298-00-0	0,0-dimethyl-0-4-nitrophenyl phosphorothioate	Bayer AG, Chemiekombinat
Methylene Chloride	79-09-2	dichloromethane	
Metiram	9006-42-2	zinc ammoniate ethylenebis(dithiocarbamate)poly(ethylenethiuram disulphide)	BASF
Metolachlor	51218-45-2	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide	Ciba-Geigy
Metribuzin	21087-64-9	4-amino-6-tert-butyl-3-(methylthio)-1,2,4-triazin-5(4H)one	duPont, Mobay
Mevinphos	7786-34-7	methyl 3-(dimethoxyphosphinyloxy)but-2-enoate, (E) and (Z) isomers	Amvac, Shell
Monocrotophos	6923-22-4	dimethyl(E)-1-methyl-2-(methylcarbamoyl)vinyl phosphate	Shell
Monuron	150-68-5	3-(p-chlorophenyl)-1,1-dimethylurea	Hopkins, duPont
MSMA	2163-80-6	monosodium methanearsonate	Several
Naled	300-76-5	1,2-dibromo-2,2-dichloroethyl dimethyl phosphate	Chevron

TABLE B3. (Continued)

Active Ingredient	CAS#	Chemical Name (IUPAC)	Basic Manufacturer
Napropamide	15299-99-7	2-(alpha-naphthoxy)-N,N-diethylproprionamide	Stauffer
Octyl bicycloheptene-carboximide	113-48-4	N-(2-ethylhexyl)-8,9,10-trinorborn-5-ene-2,3-dicarboximide	McLaughlin Gormley
Oryzalin	19044-88-3	3,5-dinitro-N4-N4-dipropylsulfanilamide	Elanco
Oxadiazon	19666-30-9	2-tert-butyl-4-(2,4-dichloro-5-isopropoxy-phenyl)-delta2-1,3,4-oxadiazolin-5-one	Rhone-Poulenc
Oxycarboxin	5259-88-1	5,6-dihydro-2-methyl-N-phenyl-1,4-oxathiin-3-carboxamide 4,4-dioxide	Uniroyal
Oxydemeton-methyl	301-12-2	S-2-ethylsulphinylethyl O,O-dimethyl phosphonothioate	Bayer AG, Shell
Oxyfluorfen	42874-03-3	2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene	Rohm & Haas
Paraquat	1910-42-5	1,1'-dimethyl-4-4'-bipyridinium ion	Chevron
Parathion	56-38-2	O,O-diethyl O-(4-nitrophenyl) phosphorothioate	Bayer AG, Monsanto
PCNB (Quintozene)	82-68-8	pentachloronitrobenzene	Olin
Pentachlorophenol	87-86-5	pentachlorophenol	Vulcan
Permethrin	52645-53-1	3-(phenoxyphenyl)methyl (+/-)-cis,trans-3-(2,2-dichloroethenyl)-2,2-dimethyl cyclopropane-carboxylate	FMC, ICI Amer., Penick
Phenothrin	26002-80-2	(3-phenoxyphenyl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate	MGK, Sumitomo
Phorate	298-02-2	O,O-diethyl S-[(ethylthio)methyl] phosphorodithioate	American Cyanamid
Picloram	1918-02-1	4-amino-3,5,6-trichloropicolinic acid	Dow
Piperonyl Butoxide	51-03-6	alpha-[2-(2-butoxyethoxy)ethoxy]-4,5-(methylenedioxy)-2-propyltoluene	Several
Prometon	1610-18-0	2,4-bis(isopropylamino)-6-(methylthio)-s-triazine	Ciba-Geigy
Pronamide	23950-58-5	3,5-dichloro(N-1,1-dimethyl-2-propynyl)benzamide	Rohm & Haas
Propetamphos	58995-37-2	(E)-O-2-isopropoxy-carbonyl-1-methylvinyl O-methyl ethylphosphoramidothioate	Sandoz Ltd.
Propham	122-42-9	isopropyl carbanilate	PPG
Propoxur	114-26-1	o-isopropoxyphenyl methylcarbamate	Mobay
Pyrethrins	121-29-9	mixture of esters of pyrethrins, cinerins, and jasmolins	Several
Resmethrin	10453-86-8	(5-phenymethyl-3-furanyl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)-cyclopropanecarboxylate	Fairfield Amer., Penick
Rotenone	8379-4	1,2,12,12a-tetrahydro-2-isopropenyl-8,9-dimethoxyl[1]benzopyrano[2,4-b]furo[2,3-b][1]benzopyran-6(6aH)-one	Several
Sethoxydim	74051-80-2	2-[1-ethoxyimine)butyl]-5-[2-(ethylthio)propyl-3-hydroxy-2-cyclohexen-1-one	Nippon Soda, Schering AG
Simazine	122-34-9	2-chloro-4,6-bis(ethylamino)-s-triazine	Ciba-Geigy
Sodium Chlorate	7775-09-9	sodium chlorate	Kerr-McGee, Occidental
Sodium Metaborate	1303-96-4	disodium tetraborate	Several
Sulfometuron-methyl	74223-56-6	methyl 2[[[[(4,6-dimethyl-2-pyrimidinyl)amino]carbony]amino]sulfonyl]benzoate	duPont
Sulfotep	3689-24-5	O,O,O,O-tetraethyl dithiopyrophosphate	Bayer AG
Sulfur	7704-34-9	elemental sulfur in many formulations	Several
Sulfuryl Fluoride	2699-79-8	sulfuryl fluoride	Dow
Tebuthiuron	34014-18-1	N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea	Elanco
Temephos	3383-96-8	O,O'-(thiodi-4,1-phenylene)bis(O,O-dimethyl phosphorothioate)	American Cyanamid
Terbacil	5902-51-2	3-tert-butyl-5-chloro-6-methyluracil	duPont
Thiram	137-26-8	tetramethylthiuramdisulfide	Several
TriButylTin	688-73-3	bistributyltin oxide, several formulations	Pfister Chemical
Trichlorfon	52-68-6	dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonante	Mobay, TUCO
Triclopyr	55335-06-3	3,5,6-trichloro-2-pyridinyloxyacetic acid	Dow
Trifluralin	1582-09-8	alpha,alpha,alpha-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine	Elanco
Vernolate	1929-77-7	S-propyldipropylthiocarbamate	Stauffer
Warfarin	81-81-2	3-(alpha-acetonylbenzyl)-4-hydroxycoumarin	Several
Xylene	1330-20-7	dimethyl benzene (ortho, meta, and para isomers)	Crowley Tar, Union Chem.
Zineb	12122-67-7	zinc ethylenebisdithiocarbamate or [[1,2-ethanediylbis[carbamodithioato]]-(2)]zinc complex	Bayer AG, several
Ziram	137-30-4	Zinc dimethyldithiocarbamate	Ziram

APPENDIX C

COUNTY-WIDE PESTICIDE USAGE DATA

APPENDIX C: COUNTY-WIDE PESTICIDE USAGE DATA

Data are estimates of usage of pesticides in lb/yr in each of 12 counties of the Puget Sound basin. For those cells with no entries, a usage value was not provided by the user source or was not estimable by methods described herein, and is not meant to indicate a lack of use. For the urban use categories (i.e., cities/schools, urban land/vegetation, miscellaneous urban, private home), a high level of uncertainty in usage data precludes a definitive assessment of actual usage. Instead, those data are only considered as estimates of potential or actual use based on a standard urban population. Refer to Section 2.2.5 for method of estimation. Abbreviations used in this appendix are USDA, U.S. Department of Agriculture; USDI, U.S. Department of Interior; USDOT, U.S. Department of Transportation; USDOE, U.S. Department of Energy; WDNR, Washington Department of Natural Resources; WDOT, Washington Department of Transportation; WDOG, Washington Department of Wildlife. Descriptions of user categories are provided in Section 2.2.

TABLE C1. POPULATIONS OF PUGET SOUND COUNTIES (1980)

County	Population
Clallam	51,648
Island	44,048
Jefferson	15,965
King	1,269,749
Kitsap	147,152
Mason	31,184
Pierce	485,643
San Juan	7,838
Skagit	64,138
Snohomish	337,720
Thurston	124,264
Whatcom	106,701
Total Population of the Puget Sound Basin	2,686,050
State of Washington	4,132,000

Source: Yates and Yates 1985.

TABLE C2. CLALLAM COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Clallam	3186								1622		
2,4-D Amine	Clallam											
2,4-D Esters	Clallam											
Acephate	Clallam											
Acrolein	Clallam											
Alachlor	Clallam											
Aldicarb	Clallam											
Aldrin	Clallam											
Aluminum Phosphide	Clallam											
Aminopyridine	Clallam											
Amitrole	Clallam											
Ammonium Sulfamate	Clallam											
Atrazine	Clallam											
Azinphos-methyl	Clallam											
Bacillus Thuringiensis	Clallam											
Bendiocarb	Clallam											
Benfluralin	Clallam											
Benomyl	Clallam											
Bensulide	Clallam											
Boric Acid	Clallam											
Bromacil	Clallam											
Bromoxynil	Clallam											
Butylate	Clallam											
Cacodylic Acid	Clallam											
Captafol	Clallam											
Captan	Clallam											
Carbaryl	Clallam	247										
Carbofuran	Clallam	133										
Chloramben	Clallam											
Chlordane	Clallam											
Chlorflurenol	Clallam											
Chloropicrin	Clallam											
Chlorothalonil	Clallam											
Chlorpyrifos	Clallam											
Chlorsulfuron	Clallam											
Copper Naphthenate	Clallam											
Cuprous Oxide	Clallam											
Dalapon	Clallam											
DCPA	Clallam											
Diazinon	Clallam	32										
Dicamba	Clallam											
Dichlobenil	Clallam											
Dichloropropene	Clallam											
Dichlorvos	Clallam											
Dicofol	Clallam											
Dinoseb	Clallam	56										

TABLE C2. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Clallam											
Diphenamid	Clallam											
Diquat	Clallam											
Disulfoton	Clallam											
Diuron	Clallam											
DSMA	Clallam											
Endosulfan	Clallam											
Fenamiphos	Clallam											
Fenthion	Clallam											
Fenvalerate	Clallam											
Ferbam	Clallam											
Fosamine Ammonium	Clallam											
Glyphosate	Clallam										160	
Heptachlor	Clallam											
Hexazinone	Clallam											
Lime Sulfur	Clallam											
Lindane	Clallam											
Malathion	Clallam	14										
Maleic Hydrazide	Clallam											
Mancozeb	Clallam											
Maneb	Clallam											
MCPP	Clallam											
Mefluidide	Clallam											
Metaldehyde	Clallam											
Metam	Clallam											
Methamidophos	Clallam											
Methomyl	Clallam											
Methyl Bromide	Clallam											
Methyl Parathion	Clallam	99										
Methylene Chloride	Clallam											
Metiram	Clallam											
Metolachlor	Clallam											
Metribuzin	Clallam											
Mevinphos	Clallam											
Monocrotophos	Clallam											
Monuron	Clallam											
MSMA	Clallam											
Naled	Clallam											
Napropamide	Clallam											
Octyl bicycloheptenedi-	Clallam											
carboximide	Clallam											
Oryzalin	Clallam											
Oxadiazon	Clallam											
Oxycarboxin	Clallam											
Oxydemeton-methyl	Clallam											
Oxyfluorfen	Clallam											

TABLE C2. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Clallam											
Parathion	Clallam	290										
PCNB (Quintozene)	Clallam											
Permethrin	Clallam											
Phenothrin	Clallam											
Phorate	Clallam											
Picloram	Clallam											
Piperonyl Butoxide	Clallam									439		
Prometon	Clallam											
Pronamide	Clallam											
Propetamphos	Clallam											
Propham	Clallam											
Propoxur	Clallam											
Pyrethrins	Clallam											
Resmethrin	Clallam											
Rotenone	Clallam											
Simazine	Clallam											
Sodium Chlorate	Clallam											
Sodium Metaborate	Clallam											
Sulfometuron-methyl	Clallam											
Sulfur	Clallam										43	
Sulfuryl Fluoride	Clallam											
Tebuthiuron	Clallam											
Temephos	Clallam											
Terbacil	Clallam											
Thiram	Clallam											
TriButylTin	Clallam											
Triclopyr	Clallam											
Trifluralin	Clallam	18								4	32	
Vernolate	Clallam											
Warfarin	Clallam											
Xylene	Clallam											
Ziram	Clallam											
TOTAL		4075	0	0	0	0	0	0	0	2065	235	0

TABLE C2. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Clallam		95	118					5021
2,4-D Amine	Clallam				78				78
2,4-D Esters	Clallam					150			150
Acephate	Clallam			238		100			338
Acrolein	Clallam				90				90
Alachlor	Clallam								0
Aldicarb	Clallam								0
Aldrin	Clallam				24				24
Aluminum Phosphide	Clallam								0
Aminopyridine	Clallam								0
Amitrole	Clallam		120	54	21			16	211
Ammonium Sulfamate	Clallam								0
Atrazine	Clallam				17				17
Azinphos-methyl	Clallam			155					155
Bacillus Thuringiensis	Clallam								0
Bendiocarb	Clallam				22				22
Benfluralin	Clallam		100						100
Benomyl	Clallam			124					124
Bensulide	Clallam								0
Boric Acid	Clallam				80				80
Bromacil	Clallam								0
Bromoxynil	Clallam								0
Butylate	Clallam								0
Cacodylic Acid	Clallam		17						17
Captafol	Clallam								0
Captan	Clallam			20					20
Carbaryl	Clallam				66	460			773
Carbofuran	Clallam				16				149
Chloramben	Clallam								0
Chlordane	Clallam				956				956
Chlorflurenol	Clallam		15						15
Chloropicrin	Clallam			10	62				72
Chlorothalonil	Clallam			46		75			121
Chlorpyrifos	Clallam			170	502	80			752
Chlorsulfuron	Clallam								0
Copper Naphthenate	Clallam				15				15
Cuprous Oxide	Clallam						312		312
Dalapon	Clallam								0
DCPA	Clallam								0
Diazinon	Clallam		20	434	520	660			1666
Dicamba	Clallam		50	75		100			225
Dichlobenil	Clallam		120						120
Dichloropropene	Clallam								0
Dichlorvos	Clallam					50			50
Dicofol	Clallam					15			15
Dinoseb	Clallam				56				112

TABLE C2. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Clallam								0
Diphenamid	Clallam								0
Diquat	Clallam		75						75
Disulfoton	Clallam					75			75
Diuron	Clallam		30	65	18				113
DSMA	Clallam								0
Endosulfan	Clallam			269					269
Fenamiphos	Clallam								0
Fenthion	Clallam								0
Fenvalerate	Clallam								0
Ferbam	Clallam								0
Fosamine Ammonium	Clallam								0
Glyphosate	Clallam	160	200	98	44	100		20	782
Heptachlor	Clallam				213				213
Hexazinone	Clallam								0
Lime Sulfur	Clallam					46			46
Lindane	Clallam				52				52
Malathion	Clallam			386	262	900			1562
Maleic Hydrazide	Clallam								0
Mancozeb	Clallam								0
Maneb	Clallam								0
MCPP	Clallam			108	13	100			221
Mefluidide	Clallam								0
Metaldehyde	Clallam		45			1000			1045
Metam	Clallam								0
Methamidophos	Clallam								0
Methomyl	Clallam				17				17
Methyl Bromide	Clallam				5312				5312
Methyl Parathion	Clallam								99
Methylene Chloride	Clallam								0
Metiram	Clallam								0
Metolachlor	Clallam								0
Metribuzin	Clallam								0
Mevinphos	Clallam								0
Monocrotophos	Clallam								0
Monuron	Clallam								0
MSMA	Clallam			21	14				35
Naled	Clallam								0
Napropamide	Clallam		20						20
Octyl bicycloheptenedi-	Clallam				13				13
carboximide	Clallam								0
Oryzalin	Clallam		44	32					76
Oxadiazon	Clallam		20						20
Oxycarboxin	Clallam								0
Oxydemeton-methyl	Clallam								0
Oxyfluorfen	Clallam								0

TABLE C2. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Clallam				18				18
Parathion	Clallam								290
PCNB (Quintozene)	Clallam								0
Permethrin	Clallam								0
Phenothrin	Clallam								0
Phorate	Clallam								0
Picloram	Clallam								439
Piperonyl Butoxide	Clallam				23				23
Prometon	Clallam					90			90
Pronamide	Clallam								0
Propetamphos	Clallam				46				46
Propham	Clallam								0
Propoxur	Clallam				29	100			129
Pyrethrins	Clallam				11	26			37
Resmethrin	Clallam								0
Rotenone	Clallam					10			10
Simazine	Clallam		43	88	13				144
Sodium Chlorate	Clallam								0
Sodium Metaborate	Clallam				14				14
Sulfometuron-methyl	Clallam	90		43					176
Sulfur	Clallam				667				667
Sulfuryl Fluoride	Clallam				2324				2324
Tebuthiuron	Clallam								0
Temephos	Clallam								0
Terbacil	Clallam								0
Thiram	Clallam								0
TriButylTin	Clallam						134		134
Triclopyr	Clallam	500	150					80	766
Trifluralin	Clallam		13						31
Vernolate	Clallam								0
Warfarin	Clallam								0
Xylene	Clallam				413				413
Ziram	Clallam			335					335
TOTAL		750	1177	2889	12041	4137	446	116	27931

TABLE C3. ISLAND COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Island	2019										
2,4-D Amine	Island											
2,4-D Esters	Island											
Acephate	Island											
Acrolein	Island											
Alachlor	Island	6										
Aldicarb	Island											
Aldrin	Island											
Aluminum Phosphide	Island											
Aminopyridine	Island											
Amitrole	Island											
Ammonia Sulfamate	Island											
Atrazine	Island	2									380	
Azinphos-methyl	Island											
Bacillus Thuringiensis	Island				464							
Bendiocarb	Island											
Benfluralin	Island											
Benomyl	Island											
Bensulide	Island											
Boric Acid	Island											
Bromacil	Island				14384						13	
Bromoxynil	Island											
Butylate	Island											
Cacodylic Acid	Island											
Captafol	Island											
Captan	Island											
Carbaryl	Island	118										
Carbofuran	Island	72										
Chloramben	Island											
Chlordane	Island											
Chlorflurenol	Island											
Chloropicrin	Island											
Chlorothalonil	Island											
Chlorpyrifos	Island				11							
Chlorsulfuron	Island										2	
Copper Naphthenate	Island											
Cuprous Oxide	Island											
Dalapon	Island											
DCPA	Island											
Diazinon	Island	25										
Dicamba	Island	1011			189							
Dichlobenil	Island											
Dichloropropene	Island											
Dichlorvos	Island											
Dicofol	Island											
Dinoseb	Island	6										

TABLE C3. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Island											
Diphenamid	Island											
Diquat	Island											
Disulfoton	Island											
Diuron	Island				13663							
DSMA	Island											
Endosulfan	Island											
Fenamiphos	Island											
Fenthion	Island											
Fenvalerate	Island											
Ferbam	Island											
Fosamine Ammonium	Island											
Glyphosate	Island										60	
Heptachlor	Island											
Hexazinone	Island											
Lime Sulfur	Island				5048							
Lindane	Island											
Malathion	Island	6			709							
Maleic Hydrazide	Island											
Mancozeb	Island											
Maneb	Island											
MCPP	Island											
Mefluidide	Island											
Metaldehyde	Island											
Metam	Island											
Methamidophos	Island											
Methomyl	Island											
Methyl Bromide	Island											
Methyl Parathion	Island	10										
Methylene Chloride	Island											
Metiram	Island											
Metolachlor	Island											
Metribuzin	Island	100										
Mevinphos	Island											
Monocrotophos	Island											
Monuron	Island											
MSMA	Island											
Naled	Island											
Napropamide	Island											
Octyl bicycloheptene-carboximide	Island Island											
Oryzalin	Island											
Oxadiazon	Island											
Oxycarboxin	Island											
Oxydemeton-methyl	Island											
Oxyfluorfen	Island											

TABLE C3. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Island											
Parathion	Island	105										
PCNB (Quintozene)	Island											
Permethrin	Island											
Phenothrin	Island											
Phorate	Island											
Picloram	Island	30										
Piperonyl Butoxide	Island											
Prometon	Island											
Pronamide	Island	3										
Propetamphos	Island											
Propham	Island											
Propoxur	Island											
Pyrethrins	Island											
Resmethrin	Island											
Rotenone	Island											
Simazine	Island	60										
Sodium Chlorate	Island											
Sodium Metaborate	Island											
Sulfometuron-methyl	Island											
Sulfur	Island										27	
Sulfuryl Fluoride	Island											
Tebuthiuron	Island											
Temephos	Island											
Terbacil	Island											
Thiram	Island											
TriButylTin	Island											
Triclopyr	Island											
Trifluralin	Island	2									155	
Vernolate	Island	7										
Warfarin	Island											
Xylene	Island											
Ziram	Island											
TOTAL		3582	0	0	34468	0	0	0	0	0	637	0

TABLE C3. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Island		80	101					2200
2,4-D Amine	Island				67				67
2,4-D Esters	Island					130			130
Acephate	Island			202		80			282
Acrolein	Island				77				77
Alachlor	Island								6
Aldicarb	Island								0
Aldrin	Island				20				20
Aluminum Phosphide	Island								0
Aminopyridine	Island								0
Amitrole	Island		103	46	18				167
Ammonia Sulfamate	Island								0
Atrazine	Island				14				396
Azinphos-methyl	Island			132					132
Bacillus Thuringiensis	Island								464
Bendiocarb	Island				18				18
Benfluralin	Island		90						90
Benomyl	Island			105					105
Bensulide	Island								0
Boric Acid	Island				69				69
Bromacil	Island								14397
Bromoxynil	Island								0
Butylate	Island								0
Cacodylic Acid	Island		15						15
Captafol	Island								0
Captan	Island			18					18
Carbaryl	Island				56	390			564
Carbofuran	Island				14				86
Chloramben	Island								0
Chlordane	Island				816				816
Chlorflurenol	Island		13						13
Chloropicrin	Island				53				53
Chlorothalonil	Island			40		62			102
Chlorpyrifos	Island			145	428	70			654
Chlorsulfuron	Island								2
Copper Naphthenate	Island				12				12
Cuprous Oxide	Island						273		273
Dalapon	Island								0
DCPA	Island								0
Diazinon	Island		18	370	443	560			1416
Dicamba	Island		43	64		80			1387
Dichlobenil	Island		100						100
Dichloropropene	Island								0
Dichlorvos	Island					40			40
Dicofol	Island					13			13
Dinoseb	Island				49				55

TABLE C3. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Island								0
Diphenamid	Island								0
Diquat	Island		65						65
Disulfoton	Island					62			62
Diuron	Island		25	55	15				13758
DSMA	Island								0
Endosulfan	Island			229					229
Fenamiphos	Island								0
Fenthion	Island								0
Fenvalerate	Island								0
Ferbam	Island								0
Fosamine Ammonium	Island								0
Glyphosate	Island		170	83	38	80		50	481
Heptachlor	Island				181				181
Hexazinone	Island								0
Lime Sulfur	Island					40			5088
Lindane	Island				44				44
Malathion	Island			329	224	760			2028
Maleic Hydrazide	Island								0
Mancozeb	Island								0
Maneb	Island								0
MCPP	Island			92	11	80			183
Mefluidide	Island								0
Metaldehyde	Island		40			850			890
Metam	Island								0
Methamidophos	Island								0
Methomyl	Island				14				14
Methyl Bromide	Island				4530				4530
Methyl Parathion	Island								10
Methylene Chloride	Island								0
Metiram	Island								0
Metolachlor	Island								0
Metribuzin	Island								100
Mevinphos	Island								0
Monocrotophos	Island								0
Monuron	Island								0
MSMA	Island			19	12				31
Naled	Island								0
Napropamide	Island		10						10
Octyl bicycloheptene-carboximide	Island Island				11				11
Oryzalin	Island		40	28					0
Oxadiazon	Island		20						68
Oxycarboxin	Island								20
Oxydemeton-methyl	Island								0
Oxyfluorfen	Island								0
									0

TABLE C3. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Island				15				15
Parathion	Island								105
PCNB (Quintozene)	Island								0
Permethrin	Island								0
Phenothrin	Island								0
Phorate	Island								0
Picloram	Island								30
Piperonyl Butoxide	Island				20				20
Prometon	Island					80			80
Pronamide	Island								3
Propetamphos	Island				39				39
Propham	Island								0
Propoxur	Island				24	90			114
Pyrethrins	Island					22			22
Resmethrin	Island								0
Rotenone	Island					10			10
Simazine	Island		42	75	11				188
Sodium Chlorate	Island								0
Sodium Metaborate	Island				12				12
Sulfometuron-methyl	Island			37					64
Sulfur	Island				568				568
Sulfuryl Fluoride	Island				1982				1982
Tebuthiuron	Island								0
Temephos	Island								0
Terbacil	Island								0
Thiram	Island								0
TriButylTin	Island						117		117
Triclopyr	Island		130						285
Trifluralin	Island		12						14
Vernolate	Island								7
Warfarin	Island								0
Xylene	Island				352				352
Ziram	Island			286					286
TOTAL		0	1016	2456	10257	3499	390	50	56355

TABLE C4. JEFFERSON COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Jefferson	1510								2000	77	
2,4-D Amine	Jefferson											
2,4-D Esters	Jefferson											
Acephate	Jefferson											
Acrolein	Jefferson											
Alachlor	Jefferson											
Aldicarb	Jefferson											
Aldrin	Jefferson											
Aluminum Phosphide	Jefferson											
Aminopyridine	Jefferson											
Amitrole	Jefferson											
Ammonia Sulfamate	Jefferson											
Atrazine	Jefferson											
Azinphos-methyl	Jefferson											
Baccilus Thuringiensis	Jefferson											
Bendiocarb	Jefferson											
Benfluralin	Jefferson											
Benomyl	Jefferson											
Bensulide	Jefferson											
Boric Acid	Jefferson											
Bromacil	Jefferson									240		
Bromoxynil	Jefferson											
Butylate	Jefferson											
Cacodylic Acid	Jefferson											
Captafol	Jefferson											
Captan	Jefferson											
Carbaryl	Jefferson	80										
Carbofuran	Jefferson	14										
Chloramben	Jefferson											
Chlordane	Jefferson											
Chlorflurenol	Jefferson											
Chloropicrin	Jefferson											
Chlorothalonil	Jefferson											
Chlorpyrifos	Jefferson											
Chlorsulfuron	Jefferson									1		
Copper Naphthenate	Jefferson											
Cuprous Oxide	Jefferson											
Dalapon	Jefferson											
DCPA	Jefferson											
Diazinon	Jefferson	17										
Dicamba	Jefferson											
Dichlobenil	Jefferson										10	
Dichloropropene	Jefferson											
Dichlorvos	Jefferson											
Dicofol	Jefferson											
Dinoseb	Jefferson											

TABLE C4. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Jefferson											
Diphenamid	Jefferson											
Diquat	Jefferson											
Disulfoton	Jefferson											
Diuron	Jefferson									240	140	
DSMA	Jefferson											
Endosulfan	Jefferson											
Fenamiphos	Jefferson											
Fenthion	Jefferson											
Fenvalerate	Jefferson											
Ferbam	Jefferson											
Fosamine Ammonium	Jefferson										80	
Glyphosate	Jefferson									240	48	
Heptachlor	Jefferson											
Hexazinone	Jefferson											
Lime Sulfur	Jefferson											
Lindane	Jefferson											
Malathion	Jefferson	1										
Maleic Hydrazide	Jefferson											
Mancozeb	Jefferson											
Maneb	Jefferson											
MCPP	Jefferson											
Mefluidide	Jefferson											
Metaldehyde	Jefferson											
Metam	Jefferson											
Methamidophos	Jefferson											
Methomyl	Jefferson											
Methyl Bromide	Jefferson											
Methyl Parathion	Jefferson											
Methylene Chloride	Jefferson											
Metiram	Jefferson											
Metolachlor	Jefferson											
Metribuzin	Jefferson											
Mevinphos	Jefferson											
Monocrotophos	Jefferson											
Monuron	Jefferson											
MSMA	Jefferson											
Naled	Jefferson											
Napropamide	Jefferson											
Octyl bicycloheptenedi-	Jefferson											
carboximide	Jefferson											
Oryzalin	Jefferson											
Oxadiazon	Jefferson											
Oxycarboxin	Jefferson											
Oxydemeton-methyl	Jefferson											
Oxyfluorfen	Jefferson											

TABLE C4. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Jefferson											
Parathion	Jefferson	96										
PCNB (Quintozene)	Jefferson											
Permethrin	Jefferson											
Phenothrin	Jefferson											
Phorate	Jefferson											
Picloram	Jefferson									450		
Piperonyl Butoxide	Jefferson											
Prometon	Jefferson											
Pronamide	Jefferson											
Propetamphos	Jefferson											
Propham	Jefferson											
Propoxur	Jefferson											
Pyrethrins	Jefferson											
Resmethrin	Jefferson											
Rotenone	Jefferson											
Simazine	Jefferson											
Sodium Chlorate	Jefferson											
Sodium Metaborate	Jefferson											
Sulfometuron-methyl	Jefferson									1	16	
Sulfur	Jefferson											
Sulfuryl Fluoride	Jefferson											
Tebuthiuron	Jefferson											
Temephos	Jefferson											
Terbacil	Jefferson											
Thiram	Jefferson											
TriButylTin	Jefferson											
Triclopyr	Jefferson										34	
Trifluralin	Jefferson											
Vernolate	Jefferson											
Warfarin	Jefferson											
Xylene	Jefferson											
Ziram	Jefferson											
TOTAL		1718	0	0	0	0	0	0	0	3172	405	0

TABLE C4. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Jefferson		30	36					3653
2,4-D Amine	Jefferson				24				24
2,4-D Esters	Jefferson					40			40
Acephate	Jefferson			73		30			103
Acrolein	Jefferson				28				28
Alachlor	Jefferson								0
Aldicarb	Jefferson								0
Aldrin	Jefferson								0
Aluminum Phosphide	Jefferson								0
Aminopyridine	Jefferson								0
Amitrole	Jefferson		40	17					57
Ammonia Sulfamate	Jefferson								0
Atrazine	Jefferson								0
Azinphos-methyl	Jefferson			48					48
Baccilus Thuringiensis	Jefferson								0
Bendiocarb	Jefferson								0
Benfluralin	Jefferson		30						30
Benomyl	Jefferson								0
Bensulide	Jefferson								0
Boric Acid	Jefferson				25				25
Bromacil	Jefferson								240
Bromoxynil	Jefferson								0
Butylate	Jefferson								0
Cacodylic Acid	Jefferson								0
Captafol	Jefferson								0
Captan	Jefferson								0
Carbaryl	Jefferson				20	142			242
Carbofuran	Jefferson								14
Chloramben	Jefferson								0
Chlordane	Jefferson				296				296
Chlorflurenol	Jefferson								0
Chloropicrin	Jefferson				19				19
Chlorothalonil	Jefferson			14		25			39
Chlorpyrifos	Jefferson			52	155	25			232
Chlorsulfuron	Jefferson								1
Copper Naphthenate	Jefferson								0
Cuprous Oxide	Jefferson						93		93
Dalapon	Jefferson								0
DCPA	Jefferson								0
Diazinon	Jefferson			134	161	200			512
Dicamba	Jefferson		15	23		30			68
Dichlobenil	Jefferson		40						50
Dichloropropene	Jefferson								0
Dichlorvos	Jefferson					15			15
Dicofol	Jefferson					5			5
Dinoseb	Jefferson				17				17

TABLE C4. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Jefferson								0
Diphenamid	Jefferson								0
Diquat	Jefferson		20						20
Disulfoton	Jefferson					25			25
Diuron	Jefferson			20					400
DSMA	Jefferson								0
Endosulfan	Jefferson			83					83
Fenamiphos	Jefferson								0
Fenthion	Jefferson								0
Fenvalerate	Jefferson								0
Ferbam	Jefferson								0
Fosamine Ammonium	Jefferson								80
Glyphosate	Jefferson		60	30	14	30			422
Heptachlor	Jefferson				65				65
Hexazinone	Jefferson								0
Lime Sulfur	Jefferson					15			15
Lindane	Jefferson				16				16
Malathion	Jefferson			119	81	275			476
Maleic Hydrazide	Jefferson								0
Mancozeb	Jefferson								0
Maneb	Jefferson								0
MCPP	Jefferson			33		30			63
Mefluidide	Jefferson								0
Metaldehyde	Jefferson		14			300			314
Metam	Jefferson								0
Methamidophos	Jefferson								0
Methomyl	Jefferson								0
Methyl Bromide	Jefferson				1642				1642
Methyl Parathion	Jefferson								0
Methylene Chloride	Jefferson								0
Metiram	Jefferson								0
Metolachlor	Jefferson								0
Metribuzin	Jefferson								0
Mevinphos	Jefferson								0
Monocrotophos	Jefferson								0
Monuron	Jefferson								0
MSMA	Jefferson								0
Naled	Jefferson								0
Napropamide	Jefferson								0
Octyl bicycloheptenedi-	Jefferson								0
carboximide	Jefferson								0
Oryzalin	Jefferson		12	10					22
Oxadiazon	Jefferson								0
Oxycarboxin	Jefferson								0
Oxydemeton-methyl	Jefferson								0
Oxyfluorfen	Jefferson								0

TABLE C4. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Jefferson								0
Parathion	Jefferson								96
PCNB (Quintozene)	Jefferson								0
Permethrin	Jefferson								0
Phenothrin	Jefferson								0
Phorate	Jefferson								0
Picloram	Jefferson								450
Piperonyl Butoxide	Jefferson								0
Prometon	Jefferson					30			30
Pronamide	Jefferson								0
Propetamphos	Jefferson				14				14
Propham	Jefferson								0
Propoxur	Jefferson					33			33
Pyrethrins	Jefferson					8			8
Resmethrin	Jefferson								0
Rotenone	Jefferson					4			4
Simazine	Jefferson		15	27					42
Sodium Chlorate	Jefferson								0
Sodium Metaborate	Jefferson								0
Sulfometuron-methyl	Jefferson			13					30
Sulfur	Jefferson				206				206
Sulfuryl Fluoride	Jefferson				718				718
Tebuthiuron	Jefferson								0
Temephos	Jefferson								0
Terbacil	Jefferson								0
Thiram	Jefferson								0
TriButylTin	Jefferson						40		40
Triclopyr	Jefferson		45						79
Trifluralin	Jefferson								0
Vernolate	Jefferson								0
Warfarin	Jefferson								0
Xylene	Jefferson				128				128
Ziram	Jefferson			104					104
TOTAL		0	321	836	3629	1262	133	0	11476

TABLE C5. KING COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	King	10157				1650			15	256		38
2,4-D Amine	King					1537						
2,4-D Esters	King											
Acephate	King											
Acrolein	King											
Alachlor	King	623										165
Aldicarb	King											
Aldrin	King											
Aluminum Phosphide	King											
Aminopyridine	King											
Amitrole	King					7			2			
Ammonium Sulfamate	King											
Atrazine	King	987									1890	40
Azinphos-methyl	King											
Baccilus Thuringiensis	King											
Bendiocarb	King											
Benfluralin	King											
Benomyl	King											
Bensulide	King	6										
Boric Acid	King											
Bromacil	King	125				56						
Bromoxynil	King											
Butylate	King											
Cacodylic Acid	King											
Captafol	King	2										
Captan	King											
Carbaryl	King	1067										
Carbofuran	King	40										
Chloramben	King	74										
Chlordane	King											
Chlorflurenol	King											
Chloropicrin	King											
Chlorothalonil	King											4
Chlorpyrifos	King											
Chlorsulfuron	King											
Copper Naphthenate	King											
Cuprous Oxide	King											
Dalapon	King											
DCPA	King											
Diazinon	King	13										
Dicamba	King	12000				1304			7	228		
Dichlobenil	King	150							150		150	
Dichloropropene	King											
Dichlorvos	King											
Dicofol	King											
Dinoseb	King	103										

TABLE C5. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	King											
Diphenamid	King											
Diquat	King											
Disulfoton	King	100										
Diuron	King	15				56					2520	
DSMA	King					19						
Endosulfan	King											
Fenamiphos	King	100										
Fenthion	King											
Fenvalerate	King											
Ferbam	King											
Fosamine Ammonium	King									960	800	
Glyphosate	King					4			16		400	
Heptachlor	King											
Hexazinone	King											
Lime Sulfur	King											
Lindane	King											
Malathion	King	44			23							
Maleic Hydrazide	King											
Mancozeb	King											
Maneb	King											
MCPP	King								3			
Mefluidide	King											
Metaldehyde	King	50							50			
Metam	King											
Methamidophos	King	21										
Methomyl	King	5										
Methyl Bromide	King											
Methyl Parathion	King	65										
Methylene Chloride	King											
Metiram	King	2										
Metolachlor	King	244										90
Metribuzin	King											
Mevinphos	King											
Monocrotophos	King											
Monuron	King							400				
MSMA	King											
Naled	King											
Napropamide	King											
Octyl bicycloheptenedi-	King											
carboximide	King											
Oryzalin	King										1400	
Oxadiazon	King											
Oxycarboxin	King											
Oxydemeton-methyl	King										52	
Oxyfluorfen	King											

TABLE C5. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	King											
Parathion	King	1345										
PCNB (Quintozene)	King											
Permethrin	King											10
Phenothrin	King											
Phorate	King	450										
Picloram	King											
Piperonyl Butoxide	King											
Prometon	King					25925						
Pronamide	King	100									252	
Propetamphos	King											
Propham	King											28
Propoxur	King											
Pyrethrins	King											
Resmethrin	King											
Rotenone	King											
Simazine	King	1000							50			24
Sodium Chlorate	King											
Sodium Metaborate	King											
Sulfometuron-methyl	King					86						
Sulfur	King											
Sulfuryl Fluoride	King											
Tebuthiuron	King					8257						
Temephos	King											
Terbacil	King											
Thiram	King											
TriButylTin	King											
Triclopyr	King									47	1220	
Trifluralin	King	41										
Vernolate	King	1370										
Warfarin	King											
Xylene	King											
Ziram	King											
TOTAL		30299	0	0	23	38901	0	400	293	1491	8684	399

TABLE C5. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	King		2300	2920				705	18041
2,4-D Amine	King				1918				3455
2,4-D Esters	King				23	3700			3723
Acephate	King		35	7600	32	2400			10067
Acrolein	King				2206				2206
Alachlor	King								788
Aldicarb	King								0
Aldrin	King				585				585
Aluminum Phosphide	King				45				45
Aminopyridine	King								0
Amitrole	King		2900	1330	519				4758
Ammonium Sulfamate	King				67				67
Atrazine	King	15000			411				18328
Azinphos-methyl	King			3800					3800
Baccilus Thuringiensis	King				202				202
Bendiocarb	King		100		531				631
Benfluralin	King		2400		11				2411
Benomyl	King		15	3047	11				3073
Bensulide	King								6
Boric Acid	King				1975				1975
Bromacil	King				142				323
Bromoxynil	King				136				136
Butylate	King								0
Cacodylic Acid	King		400						400
Captafol	King								2
Captan	King			507					507
Carbaryl	King		160		1623	11300			14150
Carbofuran	King				395				435
Chloramben	King								74
Chlordane	King				23514				23514
Chlorflurenol	King		300						300
Chloropicrin	King			250	1528				1778
Chlorothalonil	King			1142	10	1800			2956
Chlorpyrifos	King		10	4190	12345	2000			18545
Chlorsulfuron	King								0
Copper Naphthenate	King				357				357
Cuprous Oxide	King						7840		7840
Dalapon	King								0
DCPA	King				19				19
Diazinon	King		500	10665	12697	15772			39647
Dicamba	King	120	1200	1855	132	2400			19246
Dichlobenil	King		3000		82				3532
Dichloropropene	King				169				169
Dichlorvos	King				96	1000			1096
Dicofol	King		25			380			405
Dinoseb	King				1397				1500

TABLE C5. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	King				80				80
Diphenamid	King								0
Diquat	King		1830		141				1971
Disulfoton	King				42	1800			1942
Diuron	King		750	1600	433				5374
DSMA	King								19
Endosulfan	King			6600					6600
Fenamiphos	King								100
Fenthion	King				89				89
Fenvalerate	King				56				56
Ferbam	King								0
Fosamine Ammonium	King								1760
Glyphosate	King	80	4800	2410	1079	2400		700	11889
Heptachlor	King				5244				5244
Hexazinone	King								0
Lime Sulfur	King					1100			1100
Lindane	King				1270				1270
Malathion	King			9500	6443	22000			38010
Maleic Hydrazide	King								0
Mancozeb	King				47				47
Maneb	King				47				47
MCPP	King			2667	329	2400			5399
Mefluidide	King		125						125
Metaldehyde	King		1000			25000			26100
Metam	King								0
Methamidophos	King								21
Methomyl	King				414				419
Methyl Bromide	King				130596				130596
Methyl Parathion	King								65
Methylene Chloride	King				188				188
Metiram	King								2
Metolachlor	King								334
Metribuzin	King								0
Mevinphos	King				141				141
Monocrotophos	King				174				174
Monuron	King								400
MSMA	King			530	339				869
Naled	King				179				179
Napropamide	King		200		19				219
Octyl bicycloheptenedi-	King				315				315
carboximide	King								0
Oryzalin	King		1100	800					3300
Oxadiazon	King		500						500
Oxycarboxin	King								0
Oxydemeton-methyl	King								52
Oxyfluorfen	King				28				28

TABLE C5. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	King				447				447
Parathion	King				21				1366
PCNB (Quintozene)	King				85				85
Permethrin	King				141				151
Phenothrin	King								0
Phorate	King								450
Picloram	King				16				16
Piperonyl Butoxide	King				564				564
Prometon	King				99	2300			28324
Pronamide	King								352
Propetamphos	King				1129				1129
Propham	King								28
Propoxur	King				705	2600			3305
Pyrethrins	King				263	600			863
Resmethrin	King				124				124
Rotenone	King					280			280
Simazine	King	15000	1150	2160	324				19708
Sodium Chlorate	King								0
Sodium Metaborate	King				334				334
Sulfometuron-methyl	King			1070	62				1218
Sulfur	King				16387				16387
Sulfuryl Fluoride	King				57134				57134
Tebuthiuron	King				15				8272
Temephos	King				18				18
Terbacil	King								0
Thiram	King				38				38
TriButylTin	King								0
Triclopyr	King	1000	3600		47			1931	7845
Trifluralin	King		350		23				414
Vernolate	King								1370
Warfarin	King								0
Xylene	King				10158				10158
Ziram	King			8253					8253
TOTAL		31200	28750	72896	299005	101232	7840	3336	624749

TABLE C6. KITSAP COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Kitsap	2463					285				308	
2,4-D Amine	Kitsap											
2,4-D Esters	Kitsap											
Acephate	Kitsap											
Acrolein	Kitsap											
Alachlor	Kitsap											
Aldicarb	Kitsap											
Aldrin	Kitsap											
Aluminum Phosphide	Kitsap											
Aminopyridine	Kitsap											
Amitrole	Kitsap											
Ammonia Sulfamate	Kitsap											
Atrazine	Kitsap											
Azinphos-methyl	Kitsap											
Bacillus Thuringiensis	Kitsap											
Bendiocarb	Kitsap											
Benfluralin	Kitsap											
Benomyl	Kitsap											
Bensulide	Kitsap											
Boric Acid	Kitsap											
Bromacil	Kitsap				305							
Bromoxynil	Kitsap											
Butylate	Kitsap											
Cacodylic Acid	Kitsap											
Captafol	Kitsap											
Captan	Kitsap											
Carbaryl	Kitsap	72										
Carbofuran	Kitsap	5										
Chloramben	Kitsap											
Chlordane	Kitsap											
Chlorflurenol	Kitsap											
Chloropicrin	Kitsap											
Chlorothalonil	Kitsap											
Chlorpyrifos	Kitsap											
Chlorsulfuron	Kitsap											
Copper Naphthenate	Kitsap											
Cuprous Oxide	Kitsap											
Dalapon	Kitsap											
DCPA	Kitsap											
Diazinon	Kitsap	18			18							
Dicamba	Kitsap	1000										
Dichlobenil	Kitsap										40	
Dichloropropene	Kitsap											
Dichlorvos	Kitsap											
Dicofol	Kitsap											
Dinoseb	Kitsap	2										

TABLE C6. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Kitsap											
Diphenamid	Kitsap											
Diquat	Kitsap											
Disulfoton	Kitsap											
Diuron	Kitsap				170						560	
DSMA	Kitsap											
Endosulfan	Kitsap											
Fenamiphos	Kitsap											
Fenthion	Kitsap											
Fenvalerate	Kitsap											
Ferbam	Kitsap				30							
Fosamine Ammonium	Kitsap										320	
Glyphosate	Kitsap										32	
Heptachlor	Kitsap											
Hexazinone	Kitsap	320										
Lime Sulfur	Kitsap											
Lindane	Kitsap											
Malathion	Kitsap	7										
Maleic Hydrazide	Kitsap											
Mancozeb	Kitsap											
Maneb	Kitsap											
MCPP	Kitsap											
Mefluidide	Kitsap											
Metaldehyde	Kitsap											
Metam	Kitsap											
Methamidophos	Kitsap	3										
Methomyl	Kitsap	70										
Methyl Bromide	Kitsap											
Methyl Parathion	Kitsap											
Methylene Chloride	Kitsap											
Metiram	Kitsap											
Metolachlor	Kitsap	2										
Metribuzin	Kitsap											
Mevinphos	Kitsap											
Monocrotophos	Kitsap											
Monuron	Kitsap											
MSMA	Kitsap											
Naled	Kitsap											
Napropamide	Kitsap											
Octyl bicycloheptenedicarboximide	Kitsap Kitsap											
Oryzalin	Kitsap											
Oxadiazon	Kitsap											
Oxycarboxin	Kitsap											
Oxydemeton-methyl	Kitsap											
Oxyfluorfen	Kitsap											

TABLE C6. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Kitsap											
Parathion	Kitsap	99										
PCNB (Quintozene)	Kitsap											
Permethrin	Kitsap											
Phenothrin	Kitsap											
Phorate	Kitsap	3										
Picloram	Kitsap	150										
Piperonyl Butoxide	Kitsap											
Prometon	Kitsap											
Pronamide	Kitsap											
Propetamphos	Kitsap											
Propham	Kitsap											
Propoxur	Kitsap											
Pyrethrins	Kitsap											
Resmethrin	Kitsap											
Rotenone	Kitsap											
Simazine	Kitsap	440										
Sodium Chlorate	Kitsap											
Sodium Metaborate	Kitsap											
Sulfometuron-methyl	Kitsap											
Sulfur	Kitsap										28	
Sulfuryl Fluoride	Kitsap											
Tebuthiuron	Kitsap											
Temephos	Kitsap											
Terbacil	Kitsap											
Thiram	Kitsap											
TriButylTin	Kitsap											
Triclopyr	Kitsap											
Trifluralin	Kitsap	1								112	64	
Vernolate	Kitsap											
Warfarin	Kitsap											
Xylene	Kitsap											
Ziram	Kitsap											
TOTAL		4655	0	0	523	0	285	0	0	112	1352	0

TABLE C6. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Kitsap		280	340					3676
2,4-D Amine	Kitsap				222				222
2,4-D Esters	Kitsap				14	430			444
Acephate	Kitsap			675		270			945
Acrolein	Kitsap				256				256
Alachlor	Kitsap								0
Aldicarb	Kitsap								0
Aldrin	Kitsap				68				68
Aluminum Phosphide	Kitsap								0
Aminopyridine	Kitsap								0
Amitrole	Kitsap		340	154	60				554
Ammonia Sulfamate	Kitsap								0
Atrazine	Kitsap	2000							2000
Azinphos-methyl	Kitsap			440					440
Bacillus Thuringiensis	Kitsap				23				23
Bendiocarb	Kitsap				62				62
Benfluralin	Kitsap		300						300
Benomyl	Kitsap			350					350
Bensulide	Kitsap								0
Boric Acid	Kitsap				229				229
Bromacil	Kitsap				16				321
Bromoxynil	Kitsap				16				16
Butylate	Kitsap								0
Cacodylic Acid	Kitsap		50						50
Captafol	Kitsap								0
Captan	Kitsap			60					60
Carbaryl	Kitsap		19		188	1310			1589
Carbofuran	Kitsap				46				51
Chloramben	Kitsap								0
Chlordane	Kitsap				2725				2725
Chlorflurenol	Kitsap		40						40
Chloropicrin	Kitsap			30	177				207
Chlorothalonil	Kitsap			130					130
Chlorpyrifos	Kitsap			485	1431	240			2156
Chlorsulfuron	Kitsap								0
Copper Naphthenate	Kitsap				41				41
Cuprous Oxide	Kitsap					200			200
Dalapon	Kitsap						900		900
DCPA	Kitsap								0
Diazinon	Kitsap		60	1230	1481	1800			4607
Dicamba	Kitsap		140	215	15	270			1640
Dichlobenil	Kitsap		350		10				400
Dichloropropene	Kitsap				20				20
Dichlorvos	Kitsap				11	150			161
Dicofol	Kitsap					45			45
Dinoseb	Kitsap				162				164

TABLE C6. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Kitsap								0
Diphenamid	Kitsap								0
Diquat	Kitsap		215		16				231
Disulfoton	Kitsap					200			200
Diuron	Kitsap		80	185	50				1045
DSMA	Kitsap								0
Endosulfan	Kitsap			765					765
Fenamiphos	Kitsap								0
Fenthion	Kitsap				10				10
Fenvalerate	Kitsap								0
Ferbam	Kitsap								30
Fosamine Ammonium	Kitsap								320
Glyphosate	Kitsap		560	280	125	270			1267
Heptachlor	Kitsap				607				607
Hexazinone	Kitsap								320
Lime Sulfur	Kitsap					130			130
Lindane	Kitsap				147				147
Malathion	Kitsap			1100	747	2500			4354
Maleic Hydrazide	Kitsap								0
Mancozeb	Kitsap								0
Maneb	Kitsap								0
MCPP	Kitsap			310	38	270			618
Mefluidide	Kitsap		15						15
Metaldehyde	Kitsap		130			2800			2930
Metam	Kitsap								0
Methamidophos	Kitsap								3
Methomyl	Kitsap				48				118
Methyl Bromide	Kitsap				15135				15135
Methyl Parathion	Kitsap								0
Methylene Chloride	Kitsap				22				22
Metiram	Kitsap								0
Metolachlor	Kitsap								2
Metribuzin	Kitsap								0
Mevinphos	Kitsap				16				16
Monocrotophos	Kitsap				20				20
Monuron	Kitsap								0
MSMA	Kitsap			62	39				101
Naled	Kitsap				21				21
Napropamide	Kitsap		20						20
Octyl bicycloheptenedicarboximide	Kitsap Kitsap				37				37 0
Oryzalin	Kitsap		130	93					223
Oxadiazon	Kitsap		60						60
Oxycarboxin	Kitsap								0
Oxydemeton-methyl	Kitsap								0
Oxyfluorfen	Kitsap								0

TABLE C6. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Kitsap				52				52
Parathion	Kitsap								99
PCNB (Quintozene)	Kitsap				10				10
Permethrin	Kitsap				16				16
Phenothrin	Kitsap								0
Phorate	Kitsap								3
Picloram	Kitsap								150
Piperonyl Butoxide	Kitsap				65				65
Prometon	Kitsap				11	270			281
Pronamide	Kitsap								0
Propetamphos	Kitsap				131				131
Propham	Kitsap								0
Propoxur	Kitsap				82	300			382
Pyrethrins	Kitsap				31	75			106
Resmethrin	Kitsap				14				14
Rotenone	Kitsap					30			30
Simazine	Kitsap		140	250	38				868
Sodium Chlorate	Kitsap								0
Sodium Metaborate	Kitsap				39				39
Sulfometuron-methyl	Kitsap			125					153
Sulfur	Kitsap				1899				1899
Sulfuryl Fluoride	Kitsap				6621				6621
Tebuthiuron	Kitsap								0
Temephos	Kitsap								0
Terbacil	Kitsap								0
Thiram	Kitsap								0
TriButylTin	Kitsap						385		385
Triclopyr	Kitsap	270	425						871
Trifluralin	Kitsap		40						41
Vernolate	Kitsap								0
Warfarin	Kitsap								0
Xylene	Kitsap				1177				1177
Ziram	Kitsap			955					955
TOTAL		2270	3394	8234	34537	11560	1285	0	68207

TABLE C7. MASON COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOE	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Mason	1256				825				80	386	
2,4-D Amine	Mason					769						
2,4-D Esters	Mason											
Acephate	Mason											
Acrolein	Mason											
Alachlor	Mason	72										
Aldicarb	Mason											
Aldrin	Mason											
Aluminum Phosphide	Mason											
Aminopyridine	Mason											
Amitrole	Mason					3						
Ammonia Sulfamate	Mason											
Atrazine	Mason	70										
Azinphos-methyl	Mason											
Baccilus Thuringiensis	Mason											
Bendiocarb	Mason											
Benfluralin	Mason	48										
Benomyl	Mason											
Bensulide	Mason											
Boric Acid	Mason											
Bromacil	Mason					28						
Bromoxynil	Mason											
Butylate	Mason											
Cacodylic Acid	Mason											
Captafol	Mason											
Captan	Mason											
Carbaryl	Mason	70										
Carbofuran	Mason	20										
Chloramben	Mason											
Chlordane	Mason											
Chlorflurenol	Mason											
Chloropicrin	Mason											
Chlorothalonil	Mason											
Chlorpyrifos	Mason											
Chlorsulfuron	Mason											
Copper Naphthenate	Mason											
Cuprous Oxide	Mason											
Dalapon	Mason	40										
DCPA	Mason											
Diazinon	Mason	15										
Dicamba	Mason	1500				650				40		
Dichlobenil	Mason										50	
Dichloropropene	Mason											
Dichlorvos	Mason											
Dicofol	Mason											
Dinoseb	Mason											

TABLE C7. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOE	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Mason											
Diphenamid	Mason											
Diquat	Mason											
Disulfoton	Mason											
Diuron	Mason	300				28					700	
DSMA	Mason					9						
Endosulfan	Mason											
Fenamiphos	Mason											
Fenthion	Mason											
Fenvalerate	Mason											
Ferbam	Mason											
Fosamine Ammonium	Mason										400	
Glyphosate	Mason					2					40	
Heptachlor	Mason											
Hexazinone	Mason											
Lime Sulfur	Mason											
Lindane	Mason											
Malathion	Mason	5										
Maleic Hydrazide	Mason											
Mancozeb	Mason											
Maneb	Mason											
MCPP	Mason											
Mefluidide	Mason											
Metaldehyde	Mason											
Metam	Mason											
Methamidophos	Mason											
Methomyl	Mason											
Methyl Bromide	Mason											
Methyl Parathion	Mason											
Methylene Chloride	Mason											
Metiram	Mason											
Metolachlor	Mason	9										
Metribuzin	Mason											
Mevinphos	Mason											
Monocrotophos	Mason											
Monuron	Mason											
MSMA	Mason											
Naled	Mason											
Napropamide	Mason											
Octyl bicycloheptenedi-	Mason											
carboximide	Mason											
Oryzalin	Mason											
Oxadiazon	Mason											
Oxycarboxin	Mason											
Oxydemeton-methyl	Mason											
Oxyfluorfen	Mason											

TABLE C7. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOE	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Mason											
Parathion	Mason	70										
PCNB (Quintozene)	Mason											
Permethrin	Mason											
Phenothrin	Mason											
Phorate	Mason	18										
Picloram	Mason	200										
Piperonyl Butoxide	Mason											
Prometon	Mason					12963						
Pronamide	Mason	4000										
Propetamphos	Mason											
Propham	Mason											
Propoxur	Mason											
Pyrethrins	Mason											
Resmethrin	Mason											
Rotenone	Mason											
Simazine	Mason	50000										
Sodium Chlorate	Mason											
Sodium Metaborate	Mason											
Sulfometuron-methyl	Mason					43					35	
Sulfur	Mason											
Sulfuryl Fluoride	Mason											
Tebuthiuron	Mason					4130						
Temephos	Mason											
Terbacil	Mason											
Thiram	Mason											
TriButylTin	Mason											
Triclopyr	Mason										80	
Trifluralin	Mason											
Vernolate	Mason											
Warfarin	Mason											
Xylene	Mason											
Ziram	Mason											
TOTAL		57693	0	0	0	19450	0	0	0	120	1691	0

TABLE C7. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Mason		60	70					2677
2,4-D Amine	Mason				47				816
2,4-D Esters	Mason					90			90
Acephate	Mason		2	143		60			205
Acrolein	Mason				54				54
Alachlor	Mason								72
Aldicarb	Mason								0
Aldrin	Mason				14				14
Aluminum Phosphide	Mason								0
Aminopyridine	Mason								0
Amitrole	Mason		70	32	13				118
Ammonia Sulfamate	Mason								0
Atrazine	Mason				10				80
Azinphos-methyl	Mason			95					95
Baccilus Thuringiensis	Mason								0
Bendiocarb	Mason				13				13
Benfluralin	Mason		60						108
Benomyl	Mason			75					75
Bensulide	Mason								0
Boric Acid	Mason				49				49
Bromacil	Mason								28
Bromoxynil	Mason								0
Butylate	Mason								0
Cacodylic Acid	Mason		10						10
Captafol	Mason								0
Captan	Mason			12					12
Carbaryl	Mason		4		40	280			394
Carbofuran	Mason				10				30
Chloramben	Mason								0
Chlordane	Mason				577				577
Chlorflurenol	Mason		9						9
Chloropicrin	Mason				38				38
Chlorothalonil	Mason			30		45			75
Chlorpyrifos	Mason		1	100	303	50			454
Chlorsulfuron	Mason								0
Copper Naphthenate	Mason								0
Cuprous Oxide	Mason						200		200
Dalapon	Mason								40
DCPA	Mason								0
Diazinon	Mason		13	262	314	400			1004
Dicamba	Mason		30	45		60			2325
Dichlobenil	Mason		75						125
Dichloropropene	Mason								0
Dichlorvos	Mason					30			30
Dicofol	Mason		1			10			11
Dinoseb	Mason				34				34

TABLE C7. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Mason								0
Diphenamid	Mason								0
Diquat	Mason		44						44
Disulfoton	Mason					45			45
Diuron	Mason		16	40	11				1095
DSMA	Mason								9
Endosulfan	Mason			162					162
Fenamiphos	Mason								0
Fenthion	Mason								0
Fenvalerate	Mason								0
Ferbam	Mason								0
Fosamine Ammonium	Mason								400
Glyphosate	Mason		110	60	27	60			299
Heptachlor	Mason				128				128
Hexazinone	Mason								0
Lime Sulfur	Mason					28			28
Lindane	Mason				31				31
Malathion	Mason			233	158	540			936
Maleic Hydrazide	Mason								0
Mancozeb	Mason								0
Maneb	Mason								0
MCPP	Mason			65		60			125
Mefluidide	Mason		3						3
Metaldehyde	Mason		30			600			630
Metam	Mason								0
Methamidophos	Mason								0
Methomyl	Mason				10				10
Methyl Bromide	Mason				3207				3207
Methyl Parathion	Mason								0
Methylene Chloride	Mason								0
Metiram	Mason								0
Metolachlor	Mason								9
Metribuzin	Mason								0
Mevinphos	Mason								0
Monocrotophos	Mason								0
Monuron	Mason								0
MSMA	Mason			13					13
Naled	Mason								0
Napropamide	Mason		5						5
Octyl bicycloheptenedi-	Mason								0
carboximide	Mason								0
Oryzalin	Mason		25	20					45
Oxadiazon	Mason		10						10
Oxycarboxin	Mason								0
Oxydemeton-methyl	Mason								0
Oxyfluorfen	Mason								0

TABLE C7. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Mason				11				11
Parathion	Mason								70
PCNB (Quintozene)	Mason								0
Permethrin	Mason								0
Phenothrin	Mason								0
Phorate	Mason								18
Picloram	Mason								200
Piperonyl Butoxide	Mason				14				14
Prometon	Mason					60			13023
Pronamide	Mason								4000
Propetamphos	Mason				28				28
Propham	Mason								0
Propoxur	Mason				17	65			82
Pyrethrins	Mason					16			16
Resmethrin	Mason								0
Rotenone	Mason					7			7
Simazine	Mason		30	53					50083
Sodium Chlorate	Mason								0
Sodium Metaborate	Mason								0
Sulfometuron-methyl	Mason			25					103
Sulfur	Mason				402				402
Sulfuryl Fluoride	Mason				1403				1403
Tebuthiuron	Mason								4130
Temephos	Mason								0
Terbacil	Mason								0
Thiram	Mason								0
TriButylTin	Mason						85		85
Triclopyr	Mason		90						170
Trifluralin	Mason		10						10
Vernolate	Mason								0
Warfarin	Mason								0
Xylene	Mason				249				249
Ziram	Mason			200					200
TOTAL		0	708	1735	7212	2506	285	0	91400

TABLE C8. PIERCE COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Pierce	5694	900			1237						
2,4-D Amine	Pierce					1153						
2,4-D Esters	Pierce			200625								
Acephate	Pierce											
Acrolein	Pierce											
Alachlor	Pierce	395										
Aldicarb	Pierce											
Aldrin	Pierce											
Aluminum Phosphide	Pierce											
Aminopyridine	Pierce										30	
Amitrole	Pierce					5						
Ammonium Sulfamate	Pierce											
Atrazine	Pierce	230									3000	
Azinphos-methyl	Pierce											
Bacillus Thuringiensis	Pierce											
Bendiocarb	Pierce			135								
Benfluralin	Pierce											
Benomyl	Pierce											
Bensulide	Pierce	11										
Boric Acid	Pierce			396								
Bromacil	Pierce			15000		43						
Bromoxynil	Pierce											
Butylate	Pierce	400										
Cacodylic Acid	Pierce											
Captafol	Pierce	9										
Captan	Pierce											
Carbaryl	Pierce	498										
Carbofuran	Pierce	407										
Chloramben	Pierce	100										
Chlordane	Pierce											
Chlorflurenol	Pierce											
Chloropicrin	Pierce											
Chlorothalonil	Pierce	1										
Chlorpyrifos	Pierce			134								
Chlorsulfuron	Pierce											
Copper Naphthenate	Pierce											
Cuprous Oxide	Pierce											
Dalapon	Pierce											
DCPA	Pierce											
Diazinon	Pierce	8	30									
Dicamba	Pierce	12000				978						
Dichlobenil	Pierce											
Dichloropropene	Pierce											
Dichlorvos	Pierce											
Dicofol	Pierce											
Dinoseb	Pierce	388										

TABLE C8. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Pierce											
Diphenamid	Pierce	900										
Diquat	Pierce											
Disulfoton	Pierce	1400										
Diuron	Pierce	60				43					2320	
DSMA	Pierce					14						
Endosulfan	Pierce											
Fenamiphos	Pierce	600										
Fenthion	Pierce											
Fenvalerate	Pierce										420	
Ferbam	Pierce											
Fosamine Ammonium	Pierce										880	
Glyphosate	Pierce			6620		3						
Heptachlor	Pierce											
Hexazinone	Pierce			1952						60		
Lime Sulfur	Pierce											
Lindane	Pierce											
Malathion	Pierce	51		122390								
Maleic Hydrazide	Pierce		6									
Mancozeb	Pierce											
Maneb	Pierce											
MCPP	Pierce											
Mefluidide	Pierce											
Metaldehyde	Pierce											
Metam	Pierce											
Methamidophos	Pierce											
Methomyl	Pierce	270										
Methyl Bromide	Pierce											
Methyl Parathion	Pierce											
Methylene Chloride	Pierce											
Metiram	Pierce	7										
Metolachlor	Pierce	22										
Metribuzin	Pierce											
Mevinphos	Pierce											
Monocrotophos	Pierce											
Monuron	Pierce											
MSMA	Pierce											
Naled	Pierce											
Napropamide	Pierce											
Octyl bicycloheptenedi-	Pierce											
carboximide	Pierce											
Oryzalin	Pierce										208	
Oxadiazon	Pierce											
Oxycarboxin	Pierce											
Oxydemeton-methyl	Pierce											
Oxyfluorfen	Pierce											

TABLE C8. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Pierce											
Parathion	Pierce	621										
PCNB (Quintozene)	Pierce											
Permethrin	Pierce											
Phenothrin	Pierce			753								
Phorate	Pierce	27										
Picloram	Pierce											
Piperonyl Butoxide	Pierce											
Prometon	Pierce					19444						
Pronamide	Pierce	500									120	
Propetamphos	Pierce											
Propham	Pierce											
Propoxur	Pierce		10	474								
Pyrethrins	Pierce			92								
Resmethrin	Pierce											
Rotenone	Pierce											
Simazine	Pierce	1700	365									
Sodium Chlorate	Pierce											
Sodium Metaborate	Pierce			12995								
Sulfometuron-methyl	Pierce					64						
Sulfur	Pierce											
Sulfuryl Fluoride	Pierce											
Tebuthiuron	Pierce					6192						
Temephos	Pierce											
Terbacil	Pierce	500										
Thiram	Pierce		240									
TriButylTin	Pierce											
Triclopyr	Pierce			28000						284	40	
Trifluralin	Pierce	53										
Unknown Herbicide	Pierce		1400									
Vernolate	Pierce	450										
Warfarin	Pierce		60	675								
Xylene	Pierce											
Ziram	Pierce											
TOTAL		27302	3011	390241	0	29176	0	0	0	344	7018	0

TABLE C8. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Pierce	23	980	1120				400	10354
2,4-D Amine	Pierce				734				1887
2,4-D Esters	Pierce				47	1400			202072
Acephate	Pierce		15	2230	12	900			3157
Acrolein	Pierce				844				844
Alachlor	Pierce								395
Aldicarb	Pierce								0
Aldrin	Pierce				224				224
Aluminum Phosphide	Pierce				17				17
Aminopyridine	Pierce								30
Amitrole	Pierce		1120	500	198				1823
Ammonium Sulfamate	Pierce				26				26
Atrazine	Pierce				157				3387
Azinphos-methyl	Pierce			1450					1450
Bacillus Thuringiensis	Pierce				57				57
Bendiocarb	Pierce		50		203				388
Benfluralin	Pierce		100						100
Benomyl	Pierce			1165					1165
Bensulide	Pierce								11
Boric Acid	Pierce				755				1151
Bromacil	Pierce				54				15097
Bromoxynil	Pierce				53				53
Butylate	Pierce								400
Cacodylic Acid	Pierce		160						160
Captafol	Pierce								9
Captan	Pierce			190					190
Carbaryl	Pierce		65		621	4300			5484
Carbofuran	Pierce				151				558
Chloramben	Pierce								100
Chlordane	Pierce				8993				8993
Chlorflurenol	Pierce		150						150
Chloropicrin	Pierce			100	585				685
Chlorothalonil	Pierce			440		680			1121
Chlorpyrifos	Pierce			1600	4722	780			7236
Chlorsulfuron	Pierce								0
Copper Naphthenate	Pierce				137				137
Cuprous Oxide	Pierce						2940		2940
Dalapon	Pierce								0
DCPA	Pierce								0
Diazinon	Pierce			4079	4856	5901			14874
Dicamba	Pierce	8	470	700	50	900			15106
Dichlobenil	Pierce		1200		31				1231
Dichloropropene	Pierce				65				65
Dichlorvos	Pierce				37	500			537
Dicofol	Pierce		10			150			160
Dinoseb	Pierce				534				922

TABLE C8. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Pierce				32				32
Diphenamid	Pierce								900
Diquat	Pierce		700		54				754
Disulfoton	Pierce				16	680			2096
Diuron	Pierce		280	610	165				3478
DSMA	Pierce								14
Endosulfan	Pierce			2520					2520
Fenamiphos	Pierce								600
Fenthion	Pierce				34				34
Fenvalerate	Pierce	1500	1840		22	900			4682
Ferbam	Pierce								0
Fosamine Ammonium	Pierce								880
Glyphosate	Pierce			920	423			1243	9209
Heptachlor	Pierce				2003				2003
Hexazinone	Pierce								2012
Lime Sulfur	Pierce					440			440
Lindane	Pierce				486				486
Malathion	Pierce			3630	2464	8400			136935
Maleic Hydrazide	Pierce								6
Mancozeb	Pierce				18				18
Maneb	Pierce				18				18
MCPP	Pierce			1020	126	900			2046
Mefluidide	Pierce		50						50
Metaldehyde	Pierce		400		18	9000			9418
Metam	Pierce				22				22
Methamidophos	Pierce								0
Methomyl	Pierce				158				428
Methyl Bromide	Pierce				49949				49949
Methyl Parathion	Pierce								0
Methylene Chloride	Pierce				72				72
Metiram	Pierce								7
Metolachlor	Pierce								22
Metribuzin	Pierce								0
Mevinphos	Pierce				54				54
Monocrotophos	Pierce				67				67
Monuron	Pierce								0
MSMA	Pierce			200	130				330
Naled	Pierce				68				68
Napropamide	Pierce		100						100
Octyl bicycloheptenedi-	Pierce				12				12
carboximide	Pierce								0
Oryzalin	Pierce		425	300					933
Oxadiazon	Pierce		200						200
Oxycarboxin	Pierce								0
Oxydemeton-methyl	Pierce								0
Oxyfluorfen	Pierce				11				11

TABLE C8. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Pierce				171				171
Parathion	Pierce								621
PCNB (Quintozene)	Pierce				32				32
Permethrin	Pierce				54				54
Phenothrin	Pierce								753
Phorate	Pierce								27
Picloram	Pierce								0
Piperonyl Butoxide	Pierce				216				216
Prometon	Pierce				38	900			20382
Pronamide	Pierce								620
Propetamphos	Pierce				432				432
Propham	Pierce								0
Propoxur	Pierce				270	1000			1754
Pyrethrins	Pierce				101	250			443
Resmethrin	Pierce				47				47
Rotenone	Pierce					200			200
Simazine	Pierce	8000	480	825	124				11494
Sodium Chlorate	Pierce								0
Sodium Metaborate	Pierce				128				13123
Sulfometuron-methyl	Pierce	375		400	24				863
Sulfur	Pierce				6268				6268
Sulfuryl Fluoride	Pierce				21852				21852
Tebuthiuron	Pierce								6192
Temephos	Pierce								0
Terbacil	Pierce								500
Thiram	Pierce				14				254
TriButylTin	Pierce						1260		1260
Triclopyr	Pierce	2445	1400		18			4169	36356
Trifluralin	Pierce		130						183
Unknown Herbicide	Pierce								1400
Vernolate	Pierce								450
Warfarin	Pierce								735
Xylene	Pierce				3885				3885
Ziram	Pierce			3150					3150
TOTAL		12351	10325	27149	114259	38181	4200	5812	669369

TABLE C9. SAN JUAN COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	San Juan	1850										
2,4-D Amine	San Juan											
2,4-D Esters	San Juan											
Acephate	San Juan											
Acrolein	San Juan											
Alachlor	San Juan											
Aldicarb	San Juan											
Aldrin	San Juan											
Aluminum Phosphide	San Juan											
Aminopyridine	San Juan											
Amitrole	San Juan											
Ammonia Sulfamate	San Juan											
Atrazine	San Juan											
Azinphos-methyl	San Juan											
Baccilus Thuringiensis	San Juan											
Bendiocarb	San Juan											
Benfluralin	San Juan											
Benomyl	San Juan											
Bensulide	San Juan											
Boric Acid	San Juan											
Bromacil	San Juan											
Bromoxynil	San Juan											
Butylate	San Juan											
Cacodylic Acid	San Juan											
Captafol	San Juan											
Captan	San Juan											
Carbaryl	San Juan	7										
Carbofuran	San Juan	6										
Chloramben	San Juan											
Chlordane	San Juan											
Chlorflurenol	San Juan											
Chloropicrin	San Juan											
Chlorothalonil	San Juan											
Chlorpyrifos	San Juan											
Chlorsulfuron	San Juan											
Copper Naphthenate	San Juan											
Cuprous Oxide	San Juan											
Dalapon	San Juan											
DCPA	San Juan											
Diazinon	San Juan	1										
Dicamba	San Juan											
Dichlobenil	San Juan											
Dichloropropene	San Juan										0	
Dichlorvos	San Juan											
Dicofol	San Juan											
Dinoseb	San Juan											

TABLE C9. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	San Juan											
Diphenamid	San Juan											
Diquat	San Juan											
Disulfoton	San Juan											
Diuron	San Juan											
DSMA	San Juan											
Endosulfan	San Juan											
Fenamiphos	San Juan											
Fenthion	San Juan											
Fenvalerate	San Juan											
Ferbam	San Juan											
Fosamine Ammonium	San Juan											
Glyphosate	San Juan											
Heptachlor	San Juan											
Hexazinone	San Juan											
Lime Sulfur	San Juan											
Lindane	San Juan											
Malathion	San Juan											
Maleic Hydrazide	San Juan											
Mancozeb	San Juan											
Maneb	San Juan											
MCPP	San Juan											
Mefluidide	San Juan											
Metaldehyde	San Juan											
Metam	San Juan											
Methamidophos	San Juan											
Methomyl	San Juan											
Methyl Bromide	San Juan											
Methyl Parathion	San Juan											
Methylene Chloride	San Juan											
Metiram	San Juan											
Metolachlor	San Juan											
Metribuzin	San Juan											
Mevinphos	San Juan											
Monocrotophos	San Juan											
Monuron	San Juan											
MSMA	San Juan											
Naled	San Juan											
Napropamide	San Juan											
Octyl bicycloheptene-	San Juan											
carboximide	San Juan											
Oryzalin	San Juan											
Oxadiazon	San Juan											
Oxycarboxin	San Juan											
Oxydemeton-methyl	San Juan											
Oxyfluorfen	San Juan											

TABLE C9. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	San Juan											
Parathion	San Juan	2										
PCNB (Quintozene)	San Juan											
Permethrin	San Juan											
Phenothrin	San Juan											
Phorate	San Juan											
Picloram	San Juan											
Piperonyl Butoxide	San Juan											
Prometon	San Juan											
Pronamide	San Juan											
Propetamphos	San Juan											
Propham	San Juan											
Propoxur	San Juan											
Pyrethrins	San Juan											
Resmethrin	San Juan											
Rotenone	San Juan											
Simazine	San Juan											
Sodium Chlorate	San Juan											
Sodium Metaborate	San Juan											
Sulfometuron-methyl	San Juan											
Sulfur	San Juan											
Sulfuryl Fluoride	San Juan											
Tebuthiuron	San Juan											
Temephos	San Juan											
Terbacil	San Juan											
Thiram	San Juan											
TriButylTin	San Juan											
Triclopyr	San Juan											
Trifluralin	San Juan											
Vernolate	San Juan											
Warfarin	San Juan											
Xylene	San Juan											
Ziram	San Juan											
TOTAL		1866	0	0	0	0	0	0	0	0	0	0

TABLE C9. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	San Juan		15	20					1885
2,4-D Amine	San Juan				12				12
2,4-D Esters	San Juan					20			20
Acephate	San Juan			35		15			50
Acrolein	San Juan				111				111
Alachlor	San Juan								0
Aldicarb	San Juan								0
Aldrin	San Juan				30				30
Aluminum Phosphide	San Juan								0
Aminopyridine	San Juan								0
Amitrole	San Juan		15						15
Ammonia Sulfamate	San Juan								0
Atrazine	San Juan								0
Azinphos-methyl	San Juan			25					25
Baccilus Thuringiensis	San Juan								0
Bendiocarb	San Juan								0
Benfluralin	San Juan		16						16
Benomyl	San Juan			20					20
Bensulide	San Juan								0
Boric Acid	San Juan				12				12
Bromacil	San Juan								0
Bromoxynil	San Juan								0
Butylate	San Juan								0
Cacodylic Acid	San Juan								0
Captafol	San Juan								0
Captan	San Juan								0
Carbaryl	San Juan				10	70			87
Carbofuran	San Juan								6
Chloramben	San Juan								0
Chlordane	San Juan				145				145
Chlorflurenol	San Juan								0
Chloropicrin	San Juan								0
Chlorothalonil	San Juan					10			10
Chlorpyrifos	San Juan			25	76	15			116
Chlorsulfuron	San Juan								0
Copper Naphthenate	San Juan								0
Cuprous Oxide	San Juan						47		47
Dalapon	San Juan								0
DCPA	San Juan								0
Diazinon	San Juan			65	79	100			245
Dicamba	San Juan			10		15			25
Dichlobenil	San Juan		20						20
Dichloropropene	San Juan								0
Dichlorvos	San Juan					5			5
Dicofol	San Juan					3			3
Dinoseb	San Juan								0

TABLE C9. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	San Juan								0
Diphenamid	San Juan								0
Diquat	San Juan		11						11
Disulfoton	San Juan					10			10
Diuron	San Juan								0
DSMA	San Juan								0
Endosulfan	San Juan			40					40
Fenamiphos	San Juan								0
Fenthion	San Juan								0
Fenvalerate	San Juan								0
Ferbam	San Juan								0
Fosamine Ammonium	San Juan								0
Glyphosate	San Juan		29	15		15			59
Heptachlor	San Juan				32				32
Hexazinone	San Juan								0
Lime Sulfur	San Juan					10			10
Lindane	San Juan								0
Malathion	San Juan			60	40	140			240
Maleic Hydrazide	San Juan								0
Mancozeb	San Juan								0
Maneb	San Juan								0
MCPP	San Juan			16		15			31
Mefluidide	San Juan								0
Metaldehyde	San Juan		10			150			160
Metam	San Juan								0
Methamidophos	San Juan								0
Methomyl	San Juan								0
Methyl Bromide	San Juan				806				806
Methyl Parathion	San Juan								0
Methylene Chloride	San Juan								0
Metiram	San Juan								0
Metolachlor	San Juan								0
Metribuzin	San Juan								0
Mevinphos	San Juan								0
Monocrotophos	San Juan								0
Monuron	San Juan								0
MSMA	San Juan								0
Naled	San Juan								0
Napropamide	San Juan								0
Octyl bicycloheptene-	San Juan								0
carboximide	San Juan								0
Oryzalin	San Juan		10						10
Oxadiazon	San Juan								0
Oxycarboxin	San Juan								0
Oxydemeton-methyl	San Juan								0
Oxyfluorfen	San Juan								0

TABLE C9. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	San Juan								0
Parathion	San Juan								2
PCNB (Quintozene)	San Juan								0
Permethrin	San Juan								0
Phenothrin	San Juan								0
Phorate	San Juan								0
Picloram	San Juan								0
Piperonyl Butoxide	San Juan								0
Prometon	San Juan					15			15
Pronamide	San Juan								0
Propetamphos	San Juan								0
Propham	San Juan								0
Propoxur	San Juan					15			15
Pyrethrins	San Juan					4			4
Resmethrin	San Juan								0
Rotenone	San Juan					2			2
Simazine	San Juan			13					13
Sodium Chlorate	San Juan								0
Sodium Metaborate	San Juan								0
Sulfometuron-methyl	San Juan								0
Sulfur	San Juan				101				101
Sulfuryl Fluoride	San Juan				353				353
Tebuthiuron	San Juan								0
Temephos	San Juan								0
Terbacil	San Juan								0
Thiram	San Juan								0
TriButylTin	San Juan						20		20
Triclopyr	San Juan		25						25
Trifluralin	San Juan								0
Vernolate	San Juan								0
Warfarin	San Juan								0
Xylene	San Juan				63				63
Ziram	San Juan			50					50
TOTAL		0	151	394	1870	629	67	0	4977

TABLE C10. SKAGIT COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Skagit	9336				413				200		150
2,4-D Amine	Skagit					384						
2,4-D Esters	Skagit											
Acephate	Skagit											
Acrolein	Skagit											
Alachlor	Skagit	3430										
Aldicarb	Skagit											
Aldrin	Skagit											
Aluminum Phosphide	Skagit											
Aminopyridine	Skagit											
Amitrole	Skagit					2						
Ammonium Sulfamate	Skagit											
Atrazine	Skagit	1938									2400	30
Azinphos-methyl	Skagit											
Bacillus Thuringiensis	Skagit											
Bendiocarb	Skagit											
Benfluralin	Skagit											
Benomyl	Skagit											
Bensulide	Skagit	864										
Boric Acid	Skagit											
Bromacil	Skagit					14						
Bromoxynil	Skagit											
Butylate	Skagit	7000										
Cacodylic Acid	Skagit											
Captafol	Skagit	636										
Captan	Skagit											
Carbaryl	Skagit	4339										
Carbofuran	Skagit	75										
Chloramben	Skagit											
Chlordane	Skagit											
Chlorflurenol	Skagit											
Chloropicrin	Skagit											
Chlorothalonil	Skagit	41										
Chlorpyrifos	Skagit											
Chlorsulfuron	Skagit										13	
Copper Naphthenate	Skagit											
Cuprous Oxide	Skagit											
Dalapon	Skagit											
DCPA	Skagit											
Diazinon	Skagit	91										
Dicamba	Skagit	4100				326				120		40
Dichlobenil	Skagit											
Dichloropropene	Skagit											
Dichlorvos	Skagit											
Dicofol	Skagit											
Dinoseb	Skagit	4758										

TABLE C10. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Skagit											
Diphenamid	Skagit											
Diquat	Skagit											
Disulfoton	Skagit	1713										
Diuron	Skagit	650				14						
DSMA	Skagit					5						
Endosulfan	Skagit											
Fenamiphos	Skagit	250										
Fenthion	Skagit											
Fenvalerate	Skagit											
Ferbam	Skagit											
Fosamine Ammonium	Skagit											
Glyphosate	Skagit					1				262		
Heptachlor	Skagit											
Hexazinone	Skagit											
Lime Sulfur	Skagit											
Lindane	Skagit											
Malathion	Skagit	7										
Maleic Hydrazide	Skagit	100										
Mancozeb	Skagit											
Maneb	Skagit											
MCPP	Skagit											
Mefluidide	Skagit											
Metaldehyde	Skagit											
Metam	Skagit											
Methamidophos	Skagit	3917										
Methomyl	Skagit	2300										
Methyl Bromide	Skagit											
Methyl Parathion	Skagit	5155										
Methylene Chloride	Skagit											
Metiram	Skagit	418										
Metolachlor	Skagit	2257										
Metribuzin	Skagit	110										
Mevinphos	Skagit											
Monocrotophos	Skagit											
Monuron	Skagit											
MSMA	Skagit											
Naled	Skagit											
Napropamide	Skagit											
Octyl bicycloheptenedicarboximide	Skagit Skagit											
Oryzalin	Skagit											
Oxadiazon	Skagit											
Oxycarboxin	Skagit											
Oxydemeton-methyl	Skagit											
Oxyfluorfen	Skagit											

TABLE C10. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Skagit											
Parathion	Skagit	5968										
PCNB (Quintozene)	Skagit											
Permethrin	Skagit											
Phenothrin	Skagit											
Phorate	Skagit	3316										
Picloram	Skagit											
Piperonyl Butoxide	Skagit											
Prometon	Skagit					6481						
Pronamide	Skagit	500										
Propetamphos	Skagit											
Propham	Skagit	1800										
Propoxur	Skagit											
Pyrethrins	Skagit											
Resmethrin	Skagit											
Rotenone	Skagit											
Simazine	Skagit	1000										
Sodium Chlorate	Skagit											
Sodium Metaborate	Skagit											
Sulfometuron-methyl	Skagit					22					168	
Sulfur	Skagit											
Sulfuryl Fluoride	Skagit											
Tebuthiuron	Skagit					2064						
Temephos	Skagit											
Terbacil	Skagit	1100										
Thiram	Skagit											
TriButylTin	Skagit											
Triclopyr	Skagit										350	
Trifluralin	Skagit	3640										
Vernolate	Skagit	4653										
Warfarin	Skagit											
Xylene	Skagit											
Ziram	Skagit											
TOTAL		76462	0	0	0	9726	0	0	0	582	2931	220

TABLE C10. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Skagit	300	120	150					10669
2,4-D Amine	Skagit				97				481
2,4-D Esters	Skagit					190			190
Acephate	Skagit			300		120			420
Acrolein	Skagit				111				111
Alachlor	Skagit								3430
Aldicarb	Skagit								0
Aldrin	Skagit				30				30
Aluminum Phosphide	Skagit								0
Aminopyridine	Skagit								0
Amitrole	Skagit		140	65	26				233
Ammonium Sulfamate	Skagit								0
Atrazine	Skagit				21				4389
Azinphos-methyl	Skagit			190					190
Bacillus Thuringiensis	Skagit				10				10
Bendiocarb	Skagit				27				27
Benfluralin	Skagit		130						130
Benomyl	Skagit			155					155
Bensulide	Skagit								864
Boric Acid	Skagit				100				100
Bromacil	Skagit	160							174
Bromoxynil	Skagit								0
Butylate	Skagit								7000
Cacodylic Acid	Skagit		20						20
Captafol	Skagit								636
Captan	Skagit			25					25
Carbaryl	Skagit				82	570			4991
Carbofuran	Skagit				20				95
Chloramben	Skagit								0
Chlordane	Skagit				1188				1188
Chlorflurenol	Skagit		20						20
Chloropicrin	Skagit			13	77				90
Chlorothalonil	Skagit			60		90			191
Chlorpyrifos	Skagit			200	624	100			924
Chlorsulfuron	Skagit								13
Copper Naphthenate	Skagit				18				18
Cuprous Oxide	Skagit						400		400
Dalapon	Skagit								0
DCPA	Skagit								0
Diazinon	Skagit		27	540	645	820			2123
Dicamba	Skagit	240	60	90		120			5096
Dichlobenil	Skagit		150						150
Dichloropropene	Skagit								0
Dichlorvos	Skagit					70			70
Dicofol	Skagit					20			20
Dinoseb	Skagit				70				4828

TABLE C10. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Skagit								0
Diphenamid	Skagit								0
Diquat	Skagit		97						97
Disulfoton	Skagit					90			1803
Diuron	Skagit		37	80	22				803
DSMA	Skagit								5
Endosulfan	Skagit			330					330
Fenamiphos	Skagit								250
Fenthion	Skagit								0
Fenvalerate	Skagit								0
Ferbam	Skagit								0
Fosamine Ammonium	Skagit	240							240
Glyphosate	Skagit	300	230	120	56	120			1089
Heptachlor	Skagit				264				264
Hexazinone	Skagit								0
Lime Sulfur	Skagit					60			60
Lindane	Skagit				64				64
Malathion	Skagit			480	325	1100			1912
Maleic Hydrazide	Skagit								100
Mancozeb	Skagit								0
Maneb	Skagit								0
MCPP	Skagit			135	17	120			272
Mefluidide	Skagit								0
Metaldehyde	Skagit		60			1200			1260
Metam	Skagit								0
Methamidophos	Skagit								3917
Methomyl	Skagit				21				2321
Methyl Bromide	Skagit				6597				6597
Methyl Parathion	Skagit								5155
Methylene Chloride	Skagit				10				10
Metiram	Skagit								418
Metolachlor	Skagit								2257
Metribuzin	Skagit								110
Mevinphos	Skagit								0
Monocrotophos	Skagit								0
Monuron	Skagit								0
MSMA	Skagit			25	17				42
Naled	Skagit								0
Napropamide	Skagit		10						10
Octyl bicycloheptenedi-	Skagit				16				16
carboximide	Skagit								0
Oryzalin	Skagit		60						60
Oxadiazon	Skagit		30						30
Oxycarboxin	Skagit								0
Oxydemeton-methyl	Skagit								0
Oxyfluorfen	Skagit								0

TABLE C10. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Skagit				23				23
Parathion	Skagit								6968
PCNB (Quintozene)	Skagit								0
Permethrin	Skagit								0
Phenothrin	Skagit								0
Phorate	Skagit								3316
Picloram	Skagit								0
Piperonyl Butoxide	Skagit				29				29
Prometon	Skagit					100			6581
Pronamide	Skagit								500
Propetamphos	Skagit				57				57
Propham	Skagit								1800
Propoxur	Skagit				36	130			166
Pyrethrins	Skagit				13	30			43
Resmethrin	Skagit								0
Rotenone	Skagit					15			15
Simazine	Skagit		68	100	16				1184
Sodium Chlorate	Skagit								0
Sodium Metaborate	Skagit				17				17
Sulfometuron-methyl	Skagit	60		55					305
Sulfur	Skagit				828				828
Sulfuryl Fluoride	Skagit				2886				2886
Tebuthiuron	Skagit								2064
Temephos	Skagit								0
Terbacil	Skagit								1100
Thiram	Skagit								0
TriButylTin	Skagit						170		170
Triclopyr	Skagit	60	190						600
Trifluralin	Skagit		18						3658
Vernolate	Skagit								4653
Warfarin	Skagit								0
Xylene	Skagit				513				513
Ziram	Skagit			415					415
TOTAL		1360	1467	3528	14973	5065	570	0	116884

TABLE C11. SNOHOMISH COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Snohomish	13048				413				200		
2,4-D Amine	Snohomish					384						
2,4-D Esters	Snohomish											
Acephate	Snohomish											
Acrolein	Snohomish											
Alachlor	Snohomish	1761										
Aldicarb	Snohomish											
Aldrin	Snohomish											
Aluminum Phosphide	Snohomish											
Aminopyridine	Snohomish											
Amitrole	Snohomish					2						
Ammonium Sulfamate	Snohomish											
Atrazine	Snohomish	2992										
Azinphos-methyl	Snohomish											
Bacillus Thuringiensis	Snohomish											
Bendiocarb	Snohomish											
Benfluralin	Snohomish											
Benomyl	Snohomish											
Bensulide	Snohomish											
Boric Acid	Snohomish											
Bromacil	Snohomish					14					88	
Bromoxynil	Snohomish											
Butylate	Snohomish	4600										
Cacodylic Acid	Snohomish											
Captafol	Snohomish	16										
Captan	Snohomish											
Carbaryl	Snohomish	1078										
Carbofuran	Snohomish	27										
Chloramben	Snohomish											
Chlordane	Snohomish											
Chlorflurenol	Snohomish											
Chloropicrin	Snohomish											
Chlorothalonil	Snohomish	1										
Chlorpyrifos	Snohomish											
Chlorsulfuron	Snohomish											
Copper Naphthenate	Snohomish											
Cuprous Oxide	Snohomish											
Dalapon	Snohomish											
DCPA	Snohomish											
Diazinon	Snohomish	85										
Dicamba	Snohomish	4200				326				100		
Dichlobenil	Snohomish											
Dichloropropane	Snohomish											
Dichlorvos	Snohomish											
Dicofol	Snohomish											
Dinoseb	Snohomish	847										

TABLE C11. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Snohomish											
Diphenamid	Snohomish	1500										
Diquat	Snohomish											
Disulfoton	Snohomish	18										
Diuron	Snohomish	35				14					1928	
DSMA	Snohomish					5						
Endosulfan	Snohomish											
Fenamiphos	Snohomish	650										
Fenthion	Snohomish											
Fenvalerate	Snohomish											
Ferbam	Snohomish											
Fosamine Ammonium	Snohomish											
Glyphosate	Snohomish					1				262	420	
Heptachlor	Snohomish											
Hexazinone	Snohomish											
Lime Sulfur	Snohomish											
Lindane	Snohomish											
Malathion	Snohomish	9										
Maleic Hydrazide	Snohomish											
Mancozeb	Snohomish											
Maneb	Snohomish											
MCPP	Snohomish											
Mefluidide	Snohomish											
Metaldehyde	Snohomish											
Metam	Snohomish											
Methamidophos	Snohomish	80										
Methomyl	Snohomish	500										
Methyl Bromide	Snohomish											
Methyl Parathion	Snohomish	1235										
Methylene Chloride	Snohomish											
Metiram	Snohomish	11										
Metolachlor	Snohomish	776										
Metribuzin	Snohomish	40										
Mevinphos	Snohomish											
Monocrotophos	Snohomish											
Monuron	Snohomish											
MSMA	Snohomish											
Naled	Snohomish											
Napropamide	Snohomish											
Octyl bicycloheptenedi-	Snohomish											
carboximide	Snohomish											
Oryzalin	Snohomish											
Oxadiazon	Snohomish											
Oxycarboxin	Snohomish											
Oxydemeton-methyl	Snohomish											
Oxyfluorfen	Snohomish											

TABLE C11. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Snohomish											
Parathion	Snohomish	2108										
PCNB (Quintozene)	Snohomish											
Permethrin	Snohomish											
Phenothrin	Snohomish											
Phorate	Snohomish	1425										
Picloram	Snohomish											
Piperonyl Butoxide	Snohomish											
Prometon	Snohomish					6481						
Pronamide	Snohomish	200										
Propetamphos	Snohomish											
Propham	Snohomish	2300										
Propoxur	Snohomish											
Pyrethrins	Snohomish											
Resmethrin	Snohomish											
Rotenone	Snohomish											
Simazine	Snohomish	700										
Sodium Chlorate	Snohomish											
Sodium Metaborate	Snohomish											
Sulfometuron-methyl	Snohomish					22					661	
Sulfur	Snohomish											
Sulfuryl Fluoride	Snohomish											
Tebuthiuron	Snohomish					2064						
Temephos	Snohomish											
Terbacil	Snohomish	270										
Thiram	Snohomish											
TriButylTin	Snohomish											
Triclopyr	Snohomish										730	
Trifluralin	Snohomish	52										
Vernolate	Snohomish	4092										
Warfarin	Snohomish											
Xylene	Snohomish											
Ziram	Snohomish											
TOTAL		44656	0	0	0	9726	0	0	0	562	3827	0

TABLE C11. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Snohomish	23	630	775				1100	16189
2,4-D Amine	Snohomish				510				894
2,4-D Esters	Snohomish				33	990			1023
Acephate	Snohomish			1550		630			2180
Acrolein	Snohomish				587				587
Alachlor	Snohomish								1761
Aldicarb	Snohomish								0
Aldrin	Snohomish				156				156
Aluminum Phosphide	Snohomish				12				12
Aminopyridine	Snohomish								0
Amitrole	Snohomish		770	355	138				1265
Ammonium Sulfamate	Snohomish				18				18
Atrazine	Snohomish				109				3101
Azinphos-methyl	Snohomish			1000					1000
Bacillus Thuringiensis	Snohomish				54				54
Bendiocarb	Snohomish				141				141
Benfluralin	Snohomish		700						700
Benomyl	Snohomish			810					810
Bensulide	Snohomish								0
Boric Acid	Snohomish				525				525
Bromacil	Snohomish				38				140
Bromoxynil	Snohomish				37				37
Butylate	Snohomish								4600
Cacodylic Acid	Snohomish		100						100
Captafol	Snohomish								16
Captan	Snohomish			135					135
Carbaryl	Snohomish		40		432	3000			4550
Carbofuran	Snohomish				105				132
Chloramben	Snohomish								0
Chlordane	Snohomish				6254				6254
Chlorflurenol	Snohomish		100						100
Chloropicrin	Snohomish			68	407				475
Chlorothalonil	Snohomish			300		480			781
Chlorpyrifos	Snohomish			1115	3283	550			4948
Chlorsulfuron	Snohomish								0
Copper Naphthenate	Snohomish				95				95
Cuprous Oxide	Snohomish						1960		1960
Dalapon	Snohomish								0
DCPA	Snohomish								0
Diazinon	Snohomish		135	1620	3398	4300			9538
Dicamba	Snohomish	8	300	490	35	630			6089
Dichlobenil	Snohomish		800		22				822
Dichloropropane	Snohomish				45				45
Dichlorvos	Snohomish				26	300			326
Dicofol	Snohomish		10			100			110
Dinoseb	Snohomish				372				1219

TABLE C11. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Snohomish				21				21
Diphenamid	Snohomish								1500
Diquat	Snohomish		485		38				523
Disulfoton	Snohomish				11	480			509
Diuron	Snohomish		195	425	115				2712
DSMA	Snohomish								5
Endosulfan	Snohomish			1755					1755
Fenamiphos	Snohomish								650
Fenthion	Snohomish				24				24
Fenvalerate	Snohomish				15				15
Ferbam	Snohomish								0
Fosamine Ammonium	Snohomish								0
Glyphosate	Snohomish	1600	1275	640	294	630		600	5722
Heptachlor	Snohomish				1393				1393
Hexazinone	Snohomish								0
Lime Sulfur	Snohomish					300			300
Lindane	Snohomish				338				338
Malathion	Snohomish			2525	1714	5800			10048
Maleic Hydrazide	Snohomish								0
Mancozeb	Snohomish				13				13
Maneb	Snohomish				13				13
MCPP	Snohomish			710	88	630			1428
Mefluidide	Snohomish		30						30
Metaldehyde	Snohomish		300		13	6500			6813
Metam	Snohomish				15				15
Methamidophos	Snohomish								80
Methomyl	Snohomish				110				610
Methyl Bromide	Snohomish				34735				34735
Methyl Parathion	Snohomish								1235
Methylene Chloride	Snohomish				50				50
Metiram	Snohomish								11
Metolachlor	Snohomish								776
Metribuzin	Snohomish								40
Mevinphos	Snohomish				38				38
Monocrotophos	Snohomish				46				46
Monuron	Snohomish								0
MSMA	Snohomish			140	90				230
Naled	Snohomish				48				48
Napropamide	Snohomish		50						50
Octyl bicycloheptenedicarboximide	Snohomish				84				84
Oryzalin	Snohomish		100	200					300
Oxadiazon	Snohomish		260						260
Oxycarboxin	Snohomish								0
Oxydemeton-methyl	Snohomish								0
Oxyfluorfen	Snohomish								0

TABLE C11. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Snohomish				119				119
Parathion	Snohomish								2108
PCNB (Quintozene)	Snohomish				23				23
Permethrin	Snohomish				38				38
Phenothrin	Snohomish								0
Phorate	Snohomish								1425
Picloram	Snohomish								0
Piperonyl Butoxide	Snohomish				150				150
Prometon	Snohomish				26	600			7107
Pronamide	Snohomish								200
Propetamphos	Snohomish				300				300
Propham	Snohomish								2300
Propoxur	Snohomish				188	700			888
Pyrethrins	Snohomish				70	170			240
Resmethrin	Snohomish				33				33
Rotenone	Snohomish					75			75
Simazine	Snohomish	8000	320	575	86				9681
Sodium Chlorate	Snohomish								0
Sodium Metaborate	Snohomish				89				89
Sulfometuron-methyl	Snohomish	230		283	16				1212
Sulfur	Snohomish				4359				4359
Sulfuryl Fluoride	Snohomish				15196				15196
Tebuthiuron	Snohomish								2064
Temephos	Snohomish								0
Terbacil	Snohomish								270
Thiram	Snohomish				10				10
TriButylTin	Snohomish						840		840
Triclopyr	Snohomish	2400	1000		13			400	4543
Trifluralin	Snohomish		90						142
Vernolate	Snohomish								4092
Warfarin	Snohomish								0
Xylene	Snohomish				2702				2702
Ziram	Snohomish			2200					2200
TOTAL		12261	7690	17671	79556	26865	2800	2100	207714

TABLE C12. THURSTON COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Thurston	4556								188		
2,4-D Amine	Thurston											
2,4-D Esters	Thurston											
Acephate	Thurston											
Acrolein	Thurston											
Alachlor	Thurston	387										
Aldicarb	Thurston											
Aldrin	Thurston											
Aluminum Phosphide	Thurston											
Aminopyridine	Thurston											
Amitrole	Thurston											
Ammonium Sulfamate	Thurston											
Atrazine	Thurston	471									1140	
Azinphos-methyl	Thurston											
Bacillus Thuringiensis	Thurston											
Bendiocarb	Thurston	178										
Benfluralin	Thurston											
Benomyl	Thurston											
Bensulide	Thurston											
Boric Acid	Thurston	421										
Bromacil	Thurston	10000										
Bromoxynil	Thurston											
Butylate	Thurston											
Cacodylic Acid	Thurston											
Captafol	Thurston											
Captan	Thurston											
Carbaryl	Thurston	139										
Carbofuran	Thurston	18										
Chloramben	Thurston											
Chlordane	Thurston											
Chlorflurenol	Thurston											
Chloropicrin	Thurston											
Chlorothalonil	Thurston											
Chlorpyrifos	Thurston											
Chlorsulfuron	Thurston										3	
Copper Naphthenate	Thurston											
Cuprous Oxide	Thurston											
Dalapon	Thurston											
DCPA	Thurston											
Diazinon	Thurston	27										
Dicamba	Thurston									94		
Dichlobenil	Thurston											
Dichloropropane	Thurston											
Dichlorvos	Thurston											
Dicofol	Thurston											
Dinoseb	Thurston	65										

TABLE C12. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Thurston											
Diphenamid	Thurston											
Diquat	Thurston											
Disulfoton	Thurston											
Diuron	Thurston										890	
DSMA	Thurston											
Endosulfan	Thurston											
Fenamiphos	Thurston											
Fenthion	Thurston											
Fenvalerate	Thurston											
Ferbam	Thurston											
Fosamine Ammonium	Thurston											
Glyphosate	Thurston											
Heptachlor	Thurston											
Hexazinone	Thurston											
Lime Sulfur	Thurston											
Lindane	Thurston											
Malathion	Thurston	11										
Maleic Hydrazide	Thurston											
Mancozeb	Thurston											
Maneb	Thurston											
MCPP	Thurston											
Mefluidide	Thurston											
Metaldehyde	Thurston											
Metam	Thurston											
Methamidophos	Thurston	3										
Methomyl	Thurston											
Methyl Bromide	Thurston											
Methyl Parathion	Thurston											
Methylene Chloride	Thurston											
Metiram	Thurston											
Metolachlor	Thurston	94										
Metribuzin	Thurston											
Mevinphos	Thurston											
Monocrotophos	Thurston											
Monuron	Thurston											
MSMA	Thurston											
Naled	Thurston											
Napropamide	Thurston											
Octyl bicycloheptenedi-	Thurston											
carboximide	Thuston											
Oryzalin	Thurston											
Oxadiazon	Thurston											
Oxycarboxin	Thurston											
Oxydemeton-methyl	Thurston											
Oxyfluorfen	Thurston											

TABLE C12. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Thurston											
Parathion	Thurston	131										
PCNB (Quintozene)	Thurston											
Permethrin	Thurston											
Phenothrin	Thurston											
Phorate	Thurston	174										
Picloram	Thurston											
Piperonyl Butoxide	Thurston											
Prometon	Thurston											
Pronamide	Thurston											
Propetamphos	Thurston											
Propham	Thurston											
Propoxur	Thurston											
Pyrethrins	Thurston											
Resmethrin	Thurston											
Rotenone	Thurston											
Simazine	Thurston	900										
Sodium Chlorate	Thurston											
Sodium Metaborate	Thurston											
Sulfometuron-methyl	Thurston											
Sulfur	Thurston											
Sulfuryl Fluoride	Thurston											
Tebuthiuron	Thurston											
Temephos	Thurston											
Terbacil	Thurston											
Thiram	Thurston											
TriButylTin	Thurston											
Triclopyr	Thurston									143		
Trifluralin	Thurston	4										
Vernolate	Thurston	704										
Warfarin	Thurston											
Xylene	Thurston											
Ziram	Thurston											
TOTAL		18283	0	0	0	0	0	0	0	425	2033	0

TABLE C12. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Thurston		240	285				500	5769
2,4-D Amine	Thurston				188				188
2,4-D Esters	Thurston				12	360			372
Acephate	Thurston			570		230			800
Acrolein	Thurston				216				216
Alachlor	Thurston								387
Aldicarb	Thurston								0
Aldrin	Thurston				57				57
Aluminum Phosphide	Thurston								0
Aminopyridine	Thurston								0
Amitrole	Thurston		270	130	51				451
Ammonium Sulfamate	Thurston								0
Atrazine	Thurston				40				1651
Azinphos-methyl	Thurston			370					370
Bacillus Thuringiensis	Thurston				20				20
Bendiocarb	Thurston				52				230
Benfluralin	Thurston		250						250
Benomyl	Thurston			300					300
Bensulide	Thurston								0
Boric Acid	Thurston				193				614
Bromacil	Thurston				14				10014
Bromoxynil	Thurston				13				13
Butylate	Thurston								0
Cacodylic Acid	Thurston		40						40
Captafol	Thurston								0
Captan	Thurston			50					50
Carbaryl	Thurston		14		159	1100			1412
Carbofuran	Thurston				39				57
Chloramben	Thurston								0
Chlordane	Thurston				2301				2301
Chlorflurenol	Thurston		30						30
Chloropicrin	Thurston			25	150				175
Chlorothalonil	Thurston			110		175			285
Chlorpyrifos	Thurston			410	1208	200			1818
Chlorsulfuron	Thurston								3
Copper Naphthenate	Thurston				35				35
Cuprous Oxide	Thurston						780		780
Dalapon	Thurston								0
DCPA	Thurston								0
Diazinon	Thurston		50	1040	1250	1600			3967
Dicamba	Thurston		120	180	13	230			637
Dichlobenil	Thurston		300						300
Dichloropropane	Thurston				17				17
Dichlorvos	Thurston					100			100
Dicofol	Thurston					40			40
Dinoseb	Thurston				136				201

TABLE C12. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Thurston								0
Diphenamid	Thurston								0
Diquat	Thurston		180		14				194
Disulfoton	Thurston					175			175
Diuron	Thurston		75	160	42				1167
DSMA	Thurston								0
Endosulfan	Thurston			645					645
Fenamiphos	Thurston								0
Fenthion	Thurston								0
Fenvalerate	Thurston								0
Ferbam	Thurston								0
Fosamine Ammonium	Thurston								0
Glyphosate	Thurston	560	450	235	108	230			1583
Heptachlor	Thurston				512				512
Hexazinone	Thurston								0
Lime Sulfur	Thurston					100			100
Lindane	Thurston				124				124
Malathion	Thurston			930	631	2100			3672
Maleic Hydrazide	Thurston								0
Mancozeb	Thurston								0
Maneb	Thurston								0
MCPP	Thurston			260	32	230			522
Mefluidide	Thurston		12						12
Metaldehyde	Thurston		100			2400			2500
Metam	Thurston								0
Methamidophos	Thurston								3
Methomyl	Thurston				41				41
Methyl Bromide	Thurston				12781				12781
Methyl Parathion	Thurston								0
Methylene Chloride	Thurston				18				18
Metiram	Thurston								0
Metolachlor	Thurston								94
Metribuzin	Thurston								0
Mevinphos	Thurston				14				14
Monocrotophos	Thurston				17				17
Monuron	Thurston								0
MSMA	Thurston			50	33				83
Naled	Thurston				17				17
Napropamide	Thurston		20						20
Octyl bicycloheptenedicarboximide	Thurston				31				31
	Thuston								0
Oryzalin	Thurston		110	80					190
Oxadiazon	Thurston		50						50
Oxycarboxin	Thurston								0
Oxydemeton-methyl	Thurston								0
Oxyfluorfen	Thurston								0

TABLE C12. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Thurston				44				44
Parathion	Thurston								131
PCNB (Quintozene)	Thurston								0
Permethrin	Thurston				14				14
Phenothrin	Thurston								0
Phorate	Thurston								174
Picloram	Thurston								0
Piperonyl Butoxide	Thurston				55				55
Prometon	Thurston				10	225			235
Pronamide	Thurston								0
Propetamphos	Thurston				110				110
Propham	Thurston								0
Propoxur	Thurston				69	250			319
Pyrethrins	Thurston				26	60			86
Resmethrin	Thurston				12				12
Rotenone	Thurston					30			30
Simazine	Thurston		124	210	32				1266
Sodium Chlorate	Thurston								0
Sodium Metaborate	Thurston				33				33
Sulfometuron-methyl	Thurston	46		100					146
Sulfur	Thurston				1604				1604
Sulfuryl Fluoride	Thurston				5591				5591
Tebuthiuron	Thurston								0
Temephos	Thurston								0
Terbacil	Thurston								0
Thiram	Thurston								0
TriButylTin	Thurston						335		335
Triclopyr	Thurston	820	360					250	1573
Trifluralin	Thurston		34						38
Vernolate	Thurston								704
Warfarin	Thurston								0
Xylene	Thurston				994				994
Ziram	Thurston			800					800
TOTAL		1426	2829	6940	29173	9835	1115	750	72809

TABLE C13. WHATCOM COUNTY

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
2,4-D	Whatcom	6318				2062	342					
2,4-D Amine	Whatcom					1921						
2,4-D Esters	Whatcom											
Acephate	Whatcom											
Acrolein	Whatcom											
Alachlor	Whatcom	2563										
Aldicarb	Whatcom	100										
Aldrin	Whatcom											
Aluminum Phosphide	Whatcom											
Aminopyridine	Whatcom											
Amitrole	Whatcom					8						
Ammonia Sulfamate	Whatcom											
Atrazine	Whatcom	3527										20
Azinphos-methyl	Whatcom											
Bacillus Thuringiensis	Whatcom											
Bendiocarb	Whatcom											
Benfluralin	Whatcom											
Benomyl	Whatcom											
Bensulide	Whatcom											
Boric Acid	Whatcom											
Bromacil	Whatcom					71						
Bromoxynil	Whatcom											
Butylate	Whatcom											
Cacodylic Acid	Whatcom											
Captafol	Whatcom	443										
Captan	Whatcom											
Carbaryl	Whatcom	1962										
Carbofuran	Whatcom	73										
Chloramben	Whatcom											
Chlordane	Whatcom											
Chlorflurenol	Whatcom											
Chloropicrin	Whatcom											
Chlorothalonil	Whatcom	29										
Chlorpyrifos	Whatcom											
Chlorsulfuron	Whatcom										7	
Copper Naphthenate	Whatcom											
Cuprous Oxide	Whatcom											
Dalapon	Whatcom											
DCPA	Whatcom											
Diazinon	Whatcom	154										
Dicamba	Whatcom	1500				1630						1
Dichlobenil	Whatcom											
Dichloropropene	Whatcom	15000										
Dichlorvos	Whatcom											
Dicofol	Whatcom											
Dinoseb	Whatcom	3223										

TABLE C13. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Dioxathione	Whatcom											
Diphenamid	Whatcom											
Diquat	Whatcom											
Disulfoton	Whatcom	248										
Diuron	Whatcom					71						3
DSMA	Whatcom					23						
Endosulfan	Whatcom											
Fenamiphos	Whatcom											
Fenthion	Whatcom											
Fenvalerate	Whatcom											
Ferbam	Whatcom											
Fosamine Ammonium	Whatcom											
Glyphosate	Whatcom					5					440	148
Heptachlor	Whatcom											
Hexazinone	Whatcom	260										
Lime Sulfur	Whatcom											
Lindane	Whatcom											
Malathion	Whatcom	12										
Maleic Hydrazide	Whatcom											
Mancozeb	Whatcom											
Maneb	Whatcom											
MCPP	Whatcom											
Mefluidide	Whatcom											
Metaldehyde	Whatcom											
Metam	Whatcom											
Methamidophos	Whatcom	1952										
Methomyl	Whatcom											
Methyl Bromide	Whatcom											
Methyl Parathion	Whatcom	1292										
Methylene Chloride	Whatcom											
Metiram	Whatcom	290										
Metolachlor	Whatcom	1807										
Metribuzin	Whatcom	90										
Mevinphos	Whatcom											
Monocrotophos	Whatcom											
Monuron	Whatcom											
MSMA	Whatcom											
Naled	Whatcom											
Napropamide	Whatcom											
Octyl bicycloheptenedi-	Whatcom											
carboximide	Whatcom											
Oryzalin	Whatcom											
Oxadiazon	Whatcom											
Oxycarboxin	Whatcom											
Oxydemeton-methyl	Whatcom											
Oxyfluorfen	Whatcom											

TABLE C13. (Continued)

ACTIVE INGREDIENT	COUNTY	AGRICULTURE	AIR FORCE	ARMY	NAVY	US DOE	USDI	US DOT	ARMY CORPS	WDNR	WDOT	WDOG
Paraquat	Whatcom											
Parathion	Whatcom	1890										
PCNB (Quintozene)	Whatcom											
Permethrin	Whatcom											
Phenothrin	Whatcom											
Phorate	Whatcom	2743										
Picloram	Whatcom											
Piperonyl Butoxide	Whatcom											
Prometon	Whatcom					32406						
Pronamide	Whatcom	175										
Propetamphos	Whatcom											
Propham	Whatcom											
Propoxur	Whatcom											
Pyrethrins	Whatcom											
Resmethrin	Whatcom											
Rotenone	Whatcom											
Simazine	Whatcom	2300										
Sodium Chlorate	Whatcom											
Sodium Metaborate	Whatcom											
Sulfometuron-methyl	Whatcom					107					95	
Sulfur	Whatcom											
Sulfuryl Fluoride	Whatcom											
Tebuthiuron	Whatcom					10321						
Temephos	Whatcom	1700										
Terbacil	Whatcom											
Thiram	Whatcom											
TriButylTin	Whatcom											
Triclopyr	Whatcom										45	
Trifluralin	Whatcom	986										
Vernolate	Whatcom	4923										
Warfarin	Whatcom											
Xylene	Whatcom											
Ziram	Whatcom											
TOTAL		55560	0	0	0	48625	342	0	0	0	587	172

TABLE C13. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
2,4-D	Whatcom		205	245					9172
2,4-D Amine	Whatcom				161				2082
2,4-D Esters	Whatcom				10	310			320
Acephate	Whatcom			490		200			690
Acrolein	Whatcom				185				185
Alachlor	Whatcom								2563
Aldicarb	Whatcom								100
Aldrin	Whatcom				49				49
Aluminum Phosphide	Whatcom								0
Aminopyridine	Whatcom								0
Amitrole	Whatcom		245	100	44				397
Ammonia Sulfamate	Whatcom								0
Atrazine	Whatcom				35				3582
Azinphos-methyl	Whatcom			320					320
Bacillus Thuringiensis	Whatcom				35				35
Bendiocarb	Whatcom				45				45
Benfluralin	Whatcom		200						200
Benomyl	Whatcom			255					255
Bensulide	Whatcom								0
Boric Acid	Whatcom				166				166
Bromacil	Whatcom				12				83
Bromoxynil	Whatcom				12				12
Butylate	Whatcom								0
Cacodylic Acid	Whatcom		35						35
Captafol	Whatcom								443
Captan	Whatcom			40					40
Carbaryl	Whatcom		13		136	950			3061
Carbofuran	Whatcom				33				106
Chloramben	Whatcom								0
Chlordane	Whatcom				1976				1976
Chlorflurenol	Whatcom		30						30
Chloropicrin	Whatcom			20	128				148
Chlorothalonil	Whatcom			95		150			274
Chlorpyrifos	Whatcom			350	1037	170			1557
Chlorsulfuron	Whatcom								7
Copper Naphthenate	Whatcom				30				30
Cuprous Oxide	Whatcom						700		700
Dalapon	Whatcom								0
DCPA	Whatcom								0
Diazinon	Whatcom		40	900	1074	1360			3528
Dicamba	Whatcom		105	155	11	200			3602
Dichlobenil	Whatcom	20	250						270
Dichloropropene	Whatcom				14				15014
Dichlorvos	Whatcom					50			50
Dicofol	Whatcom					30			30
Dinoseb	Whatcom				117				3340

TABLE C13. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Dioxathione	Whatcom								0
Diphenamid	Whatcom								0
Diquat	Whatcom		155		12				167
Disulfoton	Whatcom					150			398
Diuron	Whatcom		60	135	36				305
DSMA	Whatcom								23
Endosulfan	Whatcom			555					555
Fenamiphos	Whatcom								0
Fenthion	Whatcom								0
Fenvalerate	Whatcom								0
Ferbam	Whatcom								0
Fosamine Ammonium	Whatcom								0
Glyphosate	Whatcom	800	400	200	93	200			2286
Heptachlor	Whatcom				439				439
Hexazinone	Whatcom								260
Lime Sulfur	Whatcom					100			100
Lindane	Whatcom				107				107
Malathion	Whatcom			800	541	1800			3153
Maleic Hydrazide	Whatcom								0
Mancozeb	Whatcom								0
Maneb	Whatcom								0
MCPP	Whatcom			225	28	200			453
Mefluidide	Whatcom		10						10
Metaldehyde	Whatcom		100			2100			2200
Metam	Whatcom								0
Methamidophos	Whatcom								1952
Methomyl	Whatcom				35				35
Methyl Bromide	Whatcom				10974				10974
Methyl Parathion	Whatcom								1292
Methylene Chloride	Whatcom				16				16
Metiram	Whatcom								290
Metolachlor	Whatcom								1807
Metribuzin	Whatcom								90
Mevinphos	Whatcom				12				12
Monocrotophos	Whatcom				15				15
Monuron	Whatcom								0
MSMA	Whatcom			45	28				73
Naled	Whatcom				15				15
Napropamide	Whatcom		50						50
Octyl bicycloheptenedi-	Whatcom				26				26
carboximide	Whatcom								0
Oryzalin	Whatcom		100	70					170
Oxadiazon	Whatcom		50						50
Oxycarboxin	Whatcom								0
Oxydemeton-methyl	Whatcom								0
Oxyfluorfen	Whatcom								0

TABLE C13. (Continued)

ACTIVE INGREDIENT	COUNTY	COUNTY ROADS	LOCAL GOVERNMENT	URBAN LAND VEGETATION	MISC URBAN	PRIVATE HOME	ANTIFOULANTS	PRIVATE TIMBER	TOTAL
Paraquat	Whatcom				38				38
Parathion	Whatcom								1890
PCNB (Quintozene)	Whatcom								0
Permethrin	Whatcom				12				12
Phenothrin	Whatcom								0
Phorate	Whatcom								2743
Picloram	Whatcom								0
Piperonyl Butoxide	Whatcom				47				47
Prometon	Whatcom					190			32596
Pronamide	Whatcom								175
Propetamphos	Whatcom				95				95
Propham	Whatcom								0
Propoxur	Whatcom				59	200			259
Pyrethrins	Whatcom				22	50			72
Resmethrin	Whatcom				10				10
Rotenone	Whatcom					25			25
Simazine	Whatcom		105	180	27				2612
Sodium Chlorate	Whatcom								0
Sodium Metaborate	Whatcom				28				28
Sulfometuron-methyl	Whatcom	150		90					442
Sulfur	Whatcom				1377				1377
Sulfuryl Fluoride	Whatcom				4801				4801
Tebuthiuron	Whatcom								10321
Temephos	Whatcom								1700
Terbacil	Whatcom								0
Thiram	Whatcom								0
TriButylTin	Whatcom						300		300
Triclopyr	Whatcom	475	200						720
Trifluralin	Whatcom		30						1016
Vernolate	Whatcom								4923
Warfarin	Whatcom								0
Xylene	Whatcom				854				854
Ziram	Whatcom			690					690
TOTAL		1445	2383	5960	25057	8435	1000	0	149566

APPENDIX D

TRENDS IN PESTICIDE USES IN THE PUGET SOUND BASIN

APPENDIX D: TRENDS IN PESTICIDE USES IN THE PUGET SOUND BASIN

Trends in the use of contemporary pesticides are of interest because of concerns for the potential for these pesticides to contaminate the environment and adversely affect nontarget organisms. Notable contemporary pesticide uses and probable trends in their use are discussed in this appendix.

D.1 URBAN USES

Pesticides have been used in urban environments for over 75 yr. However, their use intensified after the 1940s with large population shifts to suburban areas. Accurate accounts of the amount of pesticides used for urban purposes nationwide have not been possible, although U.S. EPA does provide an estimate for total urban usage derived from a variety of sources (U.S. GAO 1986). According to these statistics, out of 230 million lb of herbicide, insecticide, fungicide, and rodenticide active ingredients used each year in this country, 28 percent were applied around homes and yards and 72 percent were used by government, commercial, and industrial entities. This is comparable to the approximately 25 percent of estimated urban use pesticides that are applied to homes and yards in the Puget Sound basin (see Tables C2-C13 in Appendix C for data and Section 4.1.4 for uncertainties in these data). Another 1.24 billion lb of disinfectants and wood preservatives (accounting for a full 65 percent of total urban usage) were used in urban environs nationwide (U.S. GAO 1986). Disinfectants were not included in the pesticide usage surveys of the Puget Sound basin and their estimated usage is unknown.

Urban pesticide use is the most varied source of environmental exposure to pesticides, as compared with the more limited types and purposes of applications in agriculture and silviculture. For example, the California Department of Food and Agriculture (CDFA) lists over 30 uses for urban pesticides, including recreational areas, commercial and public buildings (e.g., restaurants, hospitals, offices, schools), parks and community gardens, homes and yards, house plants, and domestic animals (Environmental Assessment Team 1978).

Pesticides used in an urban environment also have the most varied routes of transport into the natural environment (von Rumker et al. 1972). The route with greatest potential for transport of chemicals to the aquatic environment is outfall runoff into city drainage systems. Runoff from soil applications in urban environs is not likely to be a problem because of the small area of open, uncovered soils (Ridgley 1982). Liquid formulated pesticides, which are fairly common in urban/suburban yard applications, have the greatest potential for transport into waterways, especially when applied to lawns or over pavement where adsorption to soils is minimal (von Rumker et al. 1972). Improper pesticide disposal and spills also have a high potential for transport of pesticides into aquatic environments. Evaporation, drift from aerial application, and movement through groundwater are believed to have much less potential as transport mechanisms in urban environs than in the agriculture and silviculture sectors.

The potential for release of household pesticides into aquatic environments is not known. Although over 90 percent of private households use pesticides, only one-third use them in their yards or gardens (Savage et al. 1980). However, it has been estimated that household use of pesticides represents one of the heaviest pesticide applications to any land in the U.S., possibly up to 5-10 lb/ac (von Rumker et al. 1972). This application rate contrasts with the 0.5-2.0 lb/ac common in agriculture (Gianessi 1986). Pesticide applications by commercial applicators and private households occur most extensively in late spring, generally from May through mid-June (Huisenga, F., 5 January 1988, personal communication); 80 to 90 percent of urban pesticide applications occur over this 6-wk period (von Rumker et al. 1972). Moderate to heavy rainfall, not uncommon in the Puget Sound basin during that season, may lead to significant transport to aquatic environments within and around urban settings.

Types and relative volumes of household pesticides used in the Puget Sound area were surveyed in 1981 in a garden and nursery department of a local retail outlet (Ridgley 1982). A follow-up survey conducted for this report (see Section 2.2.5.3) indicated few changes in available pesticides on the retail market shelf. Poor selling brands had been withheld by the manufacturers, but an absence of pesticide active ingredients was not noticed since the 1981 survey. However, a few new items appeared in the interim. According to the department manager, the most notable increases in sales by volume over the past few years were the herbicides glyphosate (Roundup^{TM}), the 2,4-D/dicamba/MCPP-salt mixture (Trimec^{TM}), and diquat (Lou, L., 9 February 1988, personal communication). These products will presumably continue to increase in popularity in the Puget Sound area. Anti-moss products containing various salts of iron, copper, and zinc have also become more popular with the public since 1981.

It is expected that in the future, urban pest control will rely less on the chemical approach that has been characteristic of the past few decades (Olkowski et al. 1980). New ideas in urban pest control management include biological control with insect predators, pheromones, growth regulators, and pathogens, such as *Bacillus thuringiensis* (Bt). Use of these pest control measures in a unified program that takes into account the relationship of the pests to the ecology of the host environment is considered to be the best integrated pest management approach to pest control problems (Olkowski et al. 1980).

D.2 AGRICULTURE

It is expected that the majority of pesticides currently in use in the agricultural sector of Puget Sound will continue to be used in the near future, with few exceptions. In general, decisions regarding which pesticides to be used for particular crops are reached by consensus between pesticide sellers, cooperative extension agents, and the local grange. As the use of agricultural pesticides proceeds through the Special Review process of U.S. EPA, it is anticipated that a few pesticides will be restricted for future use. For example, in 1986, U.S. EPA evoked an emergency suspension of the registration and sale of dinoseb due to concerns over potential human birth defects and male reproductive effects. In recent hearings, U.S. EPA has decided to allow its use on select crops in Washington such as dry beans and cranberries for 1988 and 1989 only.

D.3 FEDERAL AGENCIES

The types and amounts of pesticides used by federal agencies in the Puget Sound basin are expected to continue with minimal changes (Freimark 1985). The following are notable pesticide uses and trends for certain federal agencies.

D.3.1 Military Installations

Presently, military installations constitute the largest federal use of pesticides in the basin. Most pesticide usage data for federal agencies are provided in a survey by Freimark (1985). Additional sources of information on usage rates by military installations in the basin are provided below. All usage data are provided on a country-wide basis in Appendix C.

- The Department of Army pesticide usage rates are solely for Fort Lewis in Pierce County, and are for July 1984 to June 1985.

- The Department of Air Force pesticide usage is for McChord Air Force Base in Pierce County. The annual usage rate was not provided in Freimark (1985). Instead, usage was quantified for 1987 by a separate request to the Command Entomologist of the U.S. Air Force (Lang, J., 16 February 1988, personal communication).

- The Department of Navy pesticide usage in the Puget Sound basin is reported for four installations: Whidbey Island Naval Air Station (Island County), Bangor Naval Submarine Base (Kitsap County), Bremerton Naval Shipyard (Kitsap

County), and Seattle Naval Station (King County). Naval central recordkeeping provided usage information for 1983. The Naval stations in Puget Sound also store 2,4,5-T and DDT onsite, some of which are shipped to foreign countries for pest control problems.

D.3.2 U.S. Forest Service

The USFS anticipates using new forest chemical products, primarily herbicides, when they have been approved by U.S. EPA and become commercially available. However, the agency believes the chemical industry is reluctant to introduce new chemicals for the forest industry market because of its relatively small size in relation to other chemical markets (USDA 1987). New pesticides that may be considered for future use in the forest industry are metsulfuron methyl (Escort^{TM}) and sulfometuron methyl (Oust^{TM}).

D.4 STATE AGENCIES

The largest pesticide user in the state government is the Washington Department of Transportation (WDOT), who manages 40,000 ac of state right-of-ways. Usage of pesticides by WDOT is substantial in most counties and current uses are expected to continue.

Timberland owned by the State of Washington is managed by the Department of Natural Resources (WDNR) and totals 2.2 million ac statewide; however, pesticide usage on these lands is relatively small. WDNR pesticide usage primarily consists of applications to right-of-ways along state forest roads (2,700 ac). A major shift away from herbicide use by WDNR on timberlands was noted since 1984. Of the approximately 21,000 ac of timberland inspected by WDNR each year, the percentage not treated for vegetation control rose from 22 percent in 1984 to 62 percent in 1987. Of the treated land, nonherbicide techniques have increased from 12 to 35 percent (Belz, D., 5 January 1988, personal communication). Generally, these nonherbicide techniques are mechanical vegetation management.

The Washington Department of Wildlife (WDOW) manages three wildlife areas within the Puget Sound basin: Lake Terrell Wildlife Area (100 ac under crop production, Whatcom County, Nooksack Watershed), Skagit Flats Wildlife Area (325 ac under crop production, Skagit County, Skagit Watershed), and Snoqualmie Wildlife Area (600 ac under crop production, King County, Snoqualmie Watershed). These wildlife areas constitute mixed management of preserved land and land leased to tenant farmers for crop production. Pesticides are applied to the crop production lands by share croppers or by commercial applicators.

D.5 SPECIFIC PESTICIDE USES

The following pesticides have recently received increasing concern over their potential toxicity to aquatic organisms. They are used to varying degrees in the Puget Sound basin. Their usage trends are reflective of this growing awareness of toxicities and are briefly reviewed below.

D.5.1 Pentachlorophenol (PCP)

According to representatives of Greenpeace (Perivier, H., 15 March 1988, personal communication), use of PCP in the Puget Sound basin is primarily related to the treatment of utility poles and other products by the following five wood treating plants:

- McFarland Cascade, Tacoma (Pierce County)
- Wyckoff Company, West Seattle (King County)
- J.H. Baxter, Arlington (Snohomish County)
- Frank Brooks Manufacturing, Bellingham (Whatcom County)
- Oeser Company, Bellingham (Whatcom County).

Other uses in the basin are by various local sawmills for sap-stain control. The larger sawmills are located in Tacoma (Pierce County) and Everett (Snohomish County). Much of the wood treated in these mills is not used in the area but shipped overseas primarily to Japan. The relative use of PCP at other sawmill locations in the basin is not known.

Sodium pentachlorophenate is a water soluble analogue of PCP and is used in sap-stain control by certain wood mills in the Puget Sound basin. Its toxicity is slightly less than that of PCP, but the potential for sodium pentachlorophenate to migrate to and remain in the water column of the sound is considerably greater due to its solubility. However, the extent of its usage in the basin is unknown at present (Lindsay, D., 4 February 1988, personal communication).

PCP is very toxic to fish and has been detected in sediments of Puget Sound (Tetra Tech 1985, 1988a, 1988b). Some of the public concern with PCP has been over the contamination of commercial formulations of PCP with up to 2 mg/L (ppm) of chlorinated dibenzo-p-dioxins during the manufacturing process (Perivier, H., 15 March 1988, personal communication). Most notable among these are the hexa, hepta, and octa-chlorobenzo-p-dioxins. Primary concern has been their potent immunosuppressive activity, rather than their potential carcinogenicity as is the case with tetra-chlorobenzo-p-dioxin (TCDD). For example, 1,2,3,4,6,7,8-heptachlorobenzo-p-dioxin (HpCDD) has been shown to be toxic to regulatory T-cells similar to TCDD (Kerkvliet and Brauner 1987). Of further concern is the possibility that these dioxins may accumulate in biological tissue, particularly the octa-isomer, which is strongly retained by the liver of laboratory animals (Birnbaum et al. 1987).

Because of public and regulatory agency awareness of the high toxicity to nontarget organisms and the extent of contamination around many wood treatment facilities and certain estuarine ecosystems, PCP usage is decreasing nationwide. In fact, all but one of the chemical manufacturers of PCP in this country have ceased production. In addition, many sawmill users of PCP are switching to Borax-based products as an alternative in sap-stain control (Best 1988). Borax is water soluble and considered safe enough for home products use. However, in the treatment of wood for utility poles, PCP remains the choice fungicide, although alternatives to its use in this area are also being considered. For example, Seattle City Light (Kakida 1987) has proposed to shift away from PCP to copper naphthenate as a less toxic alternative in utility pole treatment.

In addition to copper and zinc naphthenates, other wood preserving compounds are being developed. The Electric Power Research Institute (EPRI) has developed two compounds, alkylammonium compounds (AACs) and ammoniacal copper carboxylates (ACCs), which it claims are less toxic to nontarget organisms than PCP, but equally effective against fungal wood rot (EPRI 1986). It is anticipated that these compounds will receive increasing attention as PCB alternatives upon approval by U.S. EPA.

D.5.2 Antifoulants

Historically, ship builders have used copper to protect their boat hulls from marine organisms, primarily barnacles, algae, and tubeworms. These organisms not only damage the ship's hull, but increase hull friction and weight, thereby increasing fuel consumption. In more recent years, antifouling paints have contained copper (i.e., cuprous oxide) as a biocidal agent. Antifouling paints have contained organotin compounds only since the mid 1970s. Most organotin-based paints still contain substantial amounts of cuprous oxide (Haafs, D., 2 February 1988, personal communication).

The major organotin ingredient in antifouling paints is bis(tributyltin) oxide, with eight minor tributyltin (TBT) compounds comprising the remaining ingredients. Organotin-based paints are categorized according to the manner in which TBT is incorporated into paint coatings and subsequently released. The first category is a conventional freely associated coating where the TBT is physically incorporated into the paint matrix. This formulation has traditionally posed the problem of a high early release rate. The second category is a copolymer paint where the TBT moiety is bound to a polymer backbone that releases TBT only by chemical hydrolysis. The release rate is controlled better, although there is still an initial short term high release rate (U.S. EPA 1985).

Organotin-based antifouling paints were introduced to Puget Sound in 1981 and major users have ranged from shipyards, shipping companies, and repair shops, to small recreational boat owners. Nationwide, there are over 30 formulations from 60 manufacturers of organotin-based paints (U.S. EPA 1985). National usage is estimated to have been approximately 800,000 lb in 1985 (U.S. EPA 1985). Sales of tin-based paints in Seattle peaked in 1985, with reductions in sales of 10 to 20 percent per year since then (Haafs, D., 2 February 1988, personal communication). Because of the potential for harmful effects of TBT-oxide on nontarget organisms, International Paints has recently phased out production of these paints, concentrating on standard cuprous oxide-based paints. Copper-based paints have always made up 90 percent of total antifouling paints sold, and will probably continue as such in the future.

Increased interest in the toxicity of TBT has accompanied its increase in usage as an antifouling agent in marine paints. Crustaceans and molluscs are particularly sensitive to TBT; mussel larvae exhibit toxic effects at levels as low as 100 ppt (Valkirs et al. 1985). There is also considerable bioaccumulation of TBT by these organisms, with oysters accumulating 3-4 orders of magnitude of TBT over ambient concentrations (Valkirs et al. 1985). It is estimated that even these values underestimate actual bioaccumulation, since equilibrium between test organisms and the media may not have been achieved in these studies (U.S. EPA 1985a). Even concentrations at sublethal levels in urban bays may pose a threat to population dynamics. Based on these findings, U.S. EPA determined that TBT-containing paints may pose a potential hazard to aquatic organisms and evoked the Special Review process to further evaluate its environmental effects. A final ruling should be issued in September 1988.

In addition, Washington State has recently passed legislation (RCW 70.54) regulating the use of TBT-based paints within the state. This law states that, effective April 1988, no TBT- or organotin-based paint can be sold within the State of Washington except paint intended for use on aluminum hulls, or when sold in small spray cans with a release rate of not more than 5 ug/cm^2/day. The law is intended to remain in effect until U.S. EPA promulgates standards for the use of TBT-based antifouling paints (expected in September 1988). Other states have considered or have passed similar legislation.

With anticipated federal restrictions on TBT use as an antifouling component of marine paints, various alternatives are being espoused as its replacement. Most attention is presently directed toward the traditional copper-based paints. According to marine paint manufacturers, state-of-the-art copper-based ablative equals or exceeds the performance of TBT copolymers (Clark 1987). Alternatives to both of these agents include ". . .something like Teflon, a non-stick material," and antibiotics such as Compound X sold in paint formulations for use on pleasure craft (Clark 1987). Toxic actions of the antibiotics are generally directed toward metabolic pathways of selected organisms, primarily barnacles, and are considered to be relatively nontoxic to nontarget organisms.

D.5.3 Thiocarbamates

U.S. EPA is currently reviewing ethylene bisthiocarbamate (EBDC) pesticides under the special review process for reregistration and will decide by October 1988 if use should be cancelled or further regulated. The Special Review was initiated by concerns for potential risks of cancer and birth defects during human exposure to EBDC pesticides. These include mancozeb, maneb, and metiram. All these pesticides degrade to ethylenethiourea (ETU), which has been shown to cause tumors, birth defects, and adverse effects in the thyroid. These pesticides are not widely used in the Puget Sound basin and their use is expected to diminish in the future.

APPENDIX E

ALGORITHM COMPUTATIONS FOR LEVEL OF CONCERN MATRIX

TABLE E1. ALGORITHM SCORES FOR DETERMINING LEVEL OF CONCERN

	ENVIRONMENTAL FATE[a]													TOXICITY				
		Persistence						Mobility			Bioaccumulation Potential							Preliminary Level of Concern
Active Ingredient	Usage	ST	St	Ht	Pt	VP	F1	K_{oc}	WS	F2	K_{ow}	BLF	F3	Fate Criterion	Acute Freshwater	Acute Marine	Chronic	Toxicity Criterion	
Pentachlorophenol	H	-	H	-	-	L	H	L	L	L	H	H	H	H	H	H	H	H	P
2,4-D Species	H	H	H	L	-	L	H	H	H	H	L	L	L	H	H	H	H	H	P
Methyl Bromide	H[b]	L	L	L	-	L	L	-	H	H	L	-	L	L	L	-	H	L	S
Malathion	H	L	L	L	H	H	L	L	L	L	L	L	L	L	H	H	H	H	S
Sulfuryl Fluoride	H[b]	-	-	-	-	-	U	-	H	H	-	-	U	U	-	-	-	U	U
Prometon	H	-	H	H	L	H	H	L	H	H	L	-	L	H	L	L	L	L	S
Simazine	H	H	H	H	H	H	H	L	L	L	L	L	L	H	L	L	H	L	S[d]
Diazinon	H	L	L	L	-	H	L	-	L	L	L	L	L	L	H	L	L	L	S[c]
Dicamba	H	H	H	H	-	H	H	H	H	H	H	-	H	H	L	L	L	L	S[d]
Metaldehyde	H[b]	-	-	-	-	-	U	-	H	H	-	-	-	U	-	-	-	U	U
Triclopyr	H	-	H	H	L	H	H	H	H	H	L	L	L	H	L	L	-	L	S[d]
Chlordane	H[b]	-	H	H	-	H	H	-	L	L	H	H	H	H	H	H	H	H	P[e]
Bromacil	H	H	H	-	-	H	H	H	H	H	L	-	L	H	L	-	L	L	S[d]
Chlorpyrifos	H[b]	L	H	-	-	H	H	L	L	L	H	H	H	H	H	H	-	H	P
Carbaryl	H	L	L	L	L	H	L	L	L	L	L	L	L	L	H	H	H	H	S[f]
Atrazine	H	H	H	H	-	H	H	H	L	H	H	L	L	H	H	L	H	H	P
Glyphosate	H	-	L	L	-	-	L	L	H	H	L	-	L	L	H	-	L	H	S
Sulfur	H[b]	-	-	-	-	-	U	-	L	L	-	-	-	U	-	-	-	U	U
Tebuthiuron	H	-	H	H	L	-	H	L	H	H	-	-	U	H	L	-	H	L	S[d]
Diuron	H	H	H	-	-	H	H	L	L	L	H	-	H	H	H	H	H	H	P
Acephate	H[b]	L	L	L	-	H	L	-	H	H	-	L	L	L	L	H	H	H	S
Ziram	H[b]	-	L	L	-	-	L	-	L	L	-	-	U	L	-	-	-	U	U
Vernolate	H	L	L	-	-	-	L	-	L	L	-	-	U	L	H	H	-	H	S
Cuprous Oxide	H	-	-	-	-	-	U	-	L	L	-	-	U	U	-	-	-	U	U
Dichloropropene	H	-	L	L	-	L	L	L	H	H	H	-	H	H	H	-	H	H	P[e]
Endosulfan	H[b]	L	H	L	-	L	L	L	L	L	H	-	H	L	H	H	H	H	S
Parathion	H	L	L	L	-	H	L	L	L	L	H	H	H	L	H	H	H	H	S
Sodium Metaborate	H	H	-	-	-	-	U	H	-	H	-	-	U	U	L	-	-	L	U
Dinoseb	H	L	-	H	L	L	L	H	H	H	H	-	H	H	L	L	H	L	S
Butylate	H	L	H	H	-	H	H	-	L	L	-	L	L	L	-	-	L	L	S
MCPP	H[b]	L	-	-	-	-	U	-	L	L	-	-	U	U	L	-	-	L	U
Heptachlor	H[b]	-	H	-	-	-	H	-	L	L	H	H	H	H	H	H	H	H	P[e]
Amitrole	H[b]	L	L	L	-	-	L	L	H	H	-	-	U	L	L	L	H	L	S
Alachlor	H	H	-	-	H	H	H	H	H	H	H	L	L	H	H	-	-	H	P
Phorate	H	-	H	L	-	H	H	L	L	L	L	-	L	L	H	H	L	H	S[f]
Azinphos-methyl	H[b]	-	-	L	-	-	L	-	L	L	-	L	L	L	H	H	-	H	S
Methyl Parathion	H	-	L	L	L	-	L	L	L	L	H	L	L	L	H	H	H	H	S
Propoxur	H[b]	-	-	-	-	L	U	-	H	H	L	H	H	U	H	-	-	H	U
Lime Sulfur	H	-	-	-	-	-	U	-	H	H	-	-	-	U	-	-	-	U	U
Disulfoton	H	-	H	L	-	L	L	L	L	L	L	-	L	L	H	L	H	H	S
Dichlobenil	H[b]	H	L	-	-	H	H	L	L	L	-	L	L	L	L	-	-	L	S

TABLE E1. (Continued)

		ENVIRONMENTAL FATE[1]													TOXICITY				
		Persistence						Mobility			Bioaccumulation Potential								
Active Ingredient	Usage	ST	St	Ht	Pt	VP	F1	K_{oc}	WS	F2	K_{ow}	BLF	F3	Fate Criterion	Acute Freshwater	Acute Marine	Chronic	Toxicity Criterion	Preliminary Level of Concern
Benomyl	H[b]	H	H	-	-	-	H	-	L	L	H	-	H	H	H	-	-	H	P[e]
Chlorothalonil	H[b]	-	L	H	H	H	H	H	L	L	L	-	L	L	-	-	H	U	U
Methamidophos	H	L	-	-	-	H	L	-	H	H	-	-	U	L	-	L	-	L	S
Pronamide	H	H	H	H	-	H	H	L	L	L	H	-	H	H	-	-	H	U	S[d]
Trifluralin	H	L	H	-	-	H	H	L	L	L	H	H	H	H	H	H	H	H	P
Oryzalin	H	H	-	-	-	-	H	L	L	L	-	-	U	L	-	-	-	U	U
Metolachlor	H	-	-	-	-	-	U	-	H	H	-	-	U	U	L	-	H	H	U
Boric Acid	H	-	-	-	-	-	U	-	H	H	-	-	U	U	L	-	-	L	U
Acrolein	H	L	-	-	-	-	L	-	-	U	-	-	U	U	L	H	-	H	U
Fenvalerate	H	-	H	-	H	-	H	-	L	L	-	H	H	H	H	-	-	H	P[c]
Sulfometuron-methyl	H	-	L	L	-	-	L	-	L	L	-	-	U	L	-	-	-	U	U
Benfluralin	H	L	-	-	L	-	L	L	L	L	-	-	U	L	H	-	-	H	S
Diquat	H	H	-	L	-	-	H	-	H	H	-	-	U	H	L	L	H	L	S
Propham	H	L	L	-	L	-	L	H	H	H	L	-	L	L	L	-	H	L	S
Methomyl	H	-	L	-	-	H	L	H	H	H	L	-	L	L	H	-	-	H	S
Chloropicrin	L	-	L	-	-	L	L	-	H	H	L	-	L	L	H	-	-	H	S
TriButylTin	L	-	-	-	-	-	U	-	-	U	-	H	H	U	-	H	-	H	S[d]
Fosamine Ammonium	L	-	L	H	-	-	L	L	H	H	-	-	U'	L	L	-	-	L	L
Lindane	L	-	H	-	-	-	H	L	L	L	H	H	H	H	H	H	-	H	S
Hexazinone	L	-	H	H	H	-	H	H	H	H	L	L	L	H	L	L	L	L	S
Dichlorvos	L	-	L	-	-	H	L	-	H	H	L	-	L	L	H	H	-	H	S
Diphenamid	L	H	H	H	H	-	H	-	H	H	L	-	L	H	-	L	L	L	S
Propetamphos	L	-	-	H	H	-	H	-	L	L	-	-	U	U	-	-	-	U	U
Pyrethrins	L	-	-	-	L	-	U	-	L	L	-	-	U	U	-	-	-	U	U
Terbacil	L	-	H	L	L	-	L	H	H	H	L	-	L	L	H	-	-	H	S
MSMA	L	L	-	H	H	L	L	-	H	H	L	H	H	H	L	L	L	L	S
Carbofuran	L	-	H	H	-	H	H	H	H	H	L	-	L	H	H	-	-	H	S
Temephos	L	-	-	H	-	-	U	-	L	L	-	-	U	U	H	-	-	H	U
Fenamiphos	L	H	-	L	-	H	H	-	H	H	-	-	U	H	H	-	-	H	S
Bendiocarb	L	-	L	L	-	H	L	-	L	L	-	H	H	L	H	-	-	H	S
Picloram	VL[g]	-	H	H	L	H	H	H	H	H	L	L	L	H	L	L	H	L	L

Pesticides are ranked by usage in descending order. Remaining pesticides on Table 3 are assigned a Low Level of Concern.

[a] F1, final Persistence value; F2, final Mobility value; F3, final Bioaccumulation Potential value. See Table 9 for explanations of other column headings.

[b] Usage highly uncertain (see Table 4).

[c] Final placement in Primary level of concern for high waterfowl toxicity.

[d] Final placement in Primary level of concern for local "hot spots" of very high usage (see Table 3 and Appendix C).

[e] Final placement in Secondary level of concern for high usage uncertainty (see Section 4.1).

[f] Final placement in Primary level of concern for degradation product(s).

[g] Usage < 1,500 lb/yr. All pesticides with usages below this value (Table 3) are assigned a low level of concern.